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PHYSICS ABSTRACTS

SECTION A

of

SCIENCE ABSTRACTS

SECTION A, PHYSICS

SECTION B, ELECTRICAL ENGINEERING

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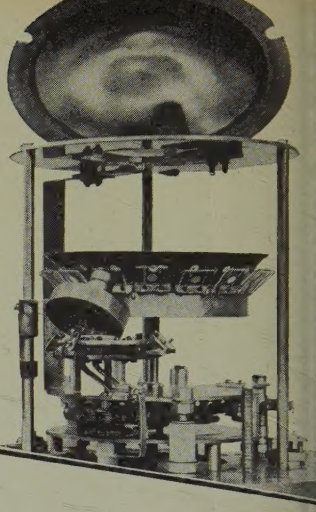
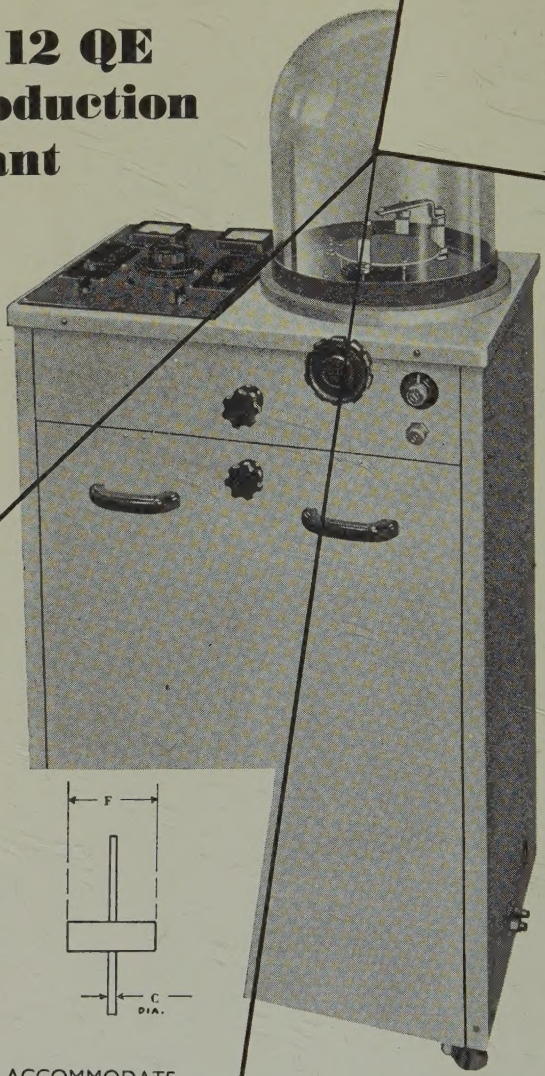
ABSTRACTS 6980–7864

VOLUME 55 **OCTOBER 1952** NUMBER 658

QUARTZ CRYSTAL COATING UNIT

Model 12 QE High Production Plant





This new equ
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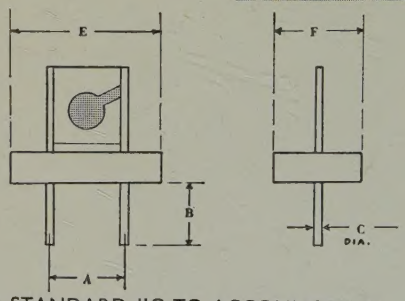
features, such

- A high deposition rate an of control which permits th adjustment of crystals alrea coated, or the complete and final adjustment *in one*
- Frequency readings can be at any time during the coa
- A turret head is designed to modate a number of crystal are rotated into calibrating p by an externally controlle

(INSET ABOVE)
Photograph of turret head of Model 1 cover removed from work-chamber.

(CENTRE)
Model 12E; the basic unit of the 12QE i suitable for the production of coated opt surface mirrors, rectifiers, photo-cell forms, shadow casting, etc.



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RELATED SUBJECTS CONTAINED IN SECTION B (ELECTRICAL ENGINEERING ABSTRACTS)

Mechanical testing
Non-destructive testing
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Electrical and magnetic measurements and instruments
Electronic relays and counters
Automatic control mechanisms
Applied electrochemistry
Photocells
Thermionic tubes
Cathode-ray tubes
X-ray tubes
Amplifiers
Radiocommunication
Mechanical engineering
Illumination
Metallurgy

LIST OF JOURNALS

The following list, together with the lists published in the preceding issues of the current volume, supplements the List of Journals published with the January number of Volume 53 (1950) and the Supplements published with the Indexes to Volume 53 (1950) and Volume 54 (1951). Reprints of the List of Journals (1950) and the Supplements (1950, 1951) can be obtained from The Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s. post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

Journals marked * are not received regularly.

**Acta Radiol.* [*Stockholm*]	*Acta Radiologica.* [Abstracted by *Photographic Abstracts.*]
**Ann. Meteorol.*	*Annalen der Meteorologie.* [Abstracted by *Meteorological Abstracts.*]
**Appl. Math. Mech.* [*Leningrad*]	*Prikladnaya Matematika i Mechanika.* Leningrad. [Abstracted by *Applied Mechanic Reviews.*]
Appl. Mech. Rev.	*Applied Mechanics Reviews.* American Society of Mechanical Engineers, 29 West 39th St., New York, 18.
**Bull. Earthquake Res. Inst.* [*Tokyo*]	*Bulletin of the Earthquake Research Institute*, Tokyo. [Abstracted by *Mathematical Reviews.*]
**Bull. Soc. Chim. Belgrade*	*Bulletin de la Société Chimique de Belgrade.* [Abstracted by *British Abstracts.*]
Chem.-Ing.-Tech.	*Chemie-Ingenieur-Technik.* Verlag Chemie, Weinheim/Bergstrasse, Pappelallee.
**Helv. Chim. Acta*	*Helvetica Chimica Acta.* [Abstracted by *British Abstracts.*]
**Publ. Sci. Minist. Air* [*France*]	*Publications scientifiques et techniques du Ministère de l'Air* [France]. [Abstracted by *Applied Mechanics Reviews.*]
**Tech. Notes Nat. Adv. Comm. Aeronaut.*	*Technical Notes of the U.S. National Advisory Committee on Aeronautics.* [Abstracted by *Meteorological Abstracts.*]
Wld Pwr Conf.	*General Reports and Papers read before the Sectional Meeting of the World Power Conference.* British National Committee, 201–2, Grand Buildings, Trafalgar Square, London, W.C.2; Central Board of Irrigation, Curzon Road Barracks, New Delhi.
**Z. angew Math. Mech.*	*Zeitschrift für angewandte Mathematik und Mechanik.* [Abstracted by *Mathematical Reviews.*]
Z. Meteorol.	*Zeitschrift für Meteorologie.* [Abstracted by *Meteorological Abstracts.*]

New Journal

Czechoslovak J. Phys.	*Czechoslovak Journal of Physics.* Central Institute of Physics, Cukrovarnická 10, Praha-Strešovice. Vol. 1, No. 1 published May, 1952, being Vol. 76 of *Časopis pro Pěstováni Matematiky a Fisiky* (Physics section). [See entry under *Čas. Pěst. Mat. Fis.* in May (1952) "List of Journals."] Four issues to be published annually. No price quoted.

Errata

Abstr. 1481 (1952), line 4: *for* 3341 (1951) *read* 781 (1952).

Abstr. 4394 (1952), line 3: *for* (*Inst. Fis. Publ. No.* 3c) *read* (*Inst. Fis. Publ. No.* 30).

Corrections to Articles

Corrections have been published, as shown below, to the articles whose Abstract numbers are given. Unless otherwise stated, the volume and page given refer to the journal named in the abstract, i.e. the journal in which the original article was published.

Abstr. 781 (1952): **12,** 951 (*Dec.*, 1951).
Abstr. 2898 (1952): **20,** 1328 (*Aug.*, 1952).
Abstr. 3297 (1952): **48,** 518 (Pt 3, 1952).
Abstr. 3752 (1952): **5,** 567 (No. 4, 1952).
Abstr. 3960 (1952): **20,** 1331 (*Aug.*, 1952).
Abstr. 4212 (1952): **9,** 336 (No. 6, 1952).
Abstr. 4965 (1952): **65,** 555 (*July*, 1952).
Abstr. 5022 (1952): **65,** 555 (*July*, 1952).
Abstr. 5217 (1952): **20,** 1180 (*July*, 1952).

MATHEMATICS 51

512.3

6980. Curve-fitting by the method of grouping. P. G. GUEST. *Aust. J. Sci. Res. A*, **5**, 238–57 (*June*, 1952).

A method of fitting polynomials is described in which the "normal" equations are obtained much more rapidly than the corresponding equations in the least squares method. Efficiencies are found to be about 90%. The method is illustrated by an example. A.

513.76

6981. Generalized spherical harmonics as representation matrix elements of rotation group. T. TAKAHASHI. *J. Phys. Soc. Japan*, **7**, 307–12 (*May–June*, 1952).

The aim of this paper is to clarify the transformation property of spherical harmonics directly from its own definition, and the circumstance that the matrix elements of the irreducible unitary representations of the 3-dimensional rotation group are the eigenfunctions of the so-called symmetric rotor. It is attempted to treat the old results more naturally and clearly from the standpoint of utilizing the generating polynomial and regarding these matrix elements as the generalization of spherical harmonics. Following this line some properties of Jacobi's polynomial are seen to be easily deduced. A.

517.512.2

6982. The Dirac delta-function and the summation of Fourier series. M. R. SPIEGEL. *J. Appl. Phys.*, **23**, 906–8 (*Aug.*, 1952).

The summation of Fourier series is attained by use of ordinary linear differential equations with constant coefficients having inputs that depend on certain combinations of the Dirac delta-function. The method is illustrated by several examples representative of those series that arise in applications. A.

517.942

6983. On the theory of the Laguerre differential equation. T. SEXL. *Acta Phys. Austriaca*, **5**, 449–60 (*No.* 4, 1952) *In German.*

The general solution is expressed in terms of contour integrals. Series and asymptotic expansions are given for integral and non-integral values of the parameter. R. A. NEWING

518.2

6984. Tables of the functions $\int_0^\phi \sin^{1/3} x\,dx$ **and** $(4/3)\sin^{-4/3}\phi \int_0^\phi \sin^{1/3} x\,dx$. M. ABRAMOWITZ. *J. Res. Nat. Bur. Stand.* [*Wash.*] **47**, 288–90 (*Oct.*, 1951).

The functions are important in the theory of condensation of vapour at rest on cylindric surfaces. The series expansion for the latter function is given, and certain functional relations useful for interpolation are mentioned. Instructions for interpolation with Lagrangian interpolations are given for the user. A.

518.2

6985. A guide to tables on punched cards. G. BLANCH AND E. C. YOWELL. *Math. Tables Aids Comput.*, **5**, 185–213 (*Oct.*, 1951).

Tables from 82 listed sources are recorded in a classified list, with a brief description of each.

518.2

6986. Table of the zeros and weight factors of the first twenty Hermite polynomials. H. E. SALZER, R. ZUCKER AND R. CAPUANO. *J. Res. Nat. Bur. Stand.* [*Wash.*] **48**, 111–16 (*Feb.*, 1952).

The chief use of this table of the zeros and weight factors of the Hermite polynomials is in the calculation of integrals over the interval $[-\infty, \infty]$, when the integrand is either the product of e^{-x^2} and a polynomial, or may be closely approximated by e^{-x^2} times a polynomial. The zeros and weight factors, $x_i^{(n)}$ and $\alpha_i^{(n)}$, respectively, together with the auxiliary quantities $\beta_i^{(n)} = \alpha_i^{(n)} \exp[(x_i^{(n)})^2]$, which are useful in computation, are all tabulated here for the first twenty Hermite polynomials. The zeros $x_i^{(n)}$ and $\beta_i^{(n)}$ are given to 13 or more decimals, and the weight factors $\alpha_i^{(n)}$ to 13 significant figures. Although other shorter tables have appeared, this present table will enable one to cope with problems requiring much higher degree and accuracy, both in problems involving direct quadratures and those arising in the numerical solution of linear integral equations for the range $[-\infty, \infty]$. Thus the use of this table in any direct quadrature can give exact accuracy as far as the 39th degree (the only inexactitude arising from the use of rounded values of $x_i^{(n)}$ and $\alpha_i^{(n)}$). Bibliography of 28 items on Hermite polynomials. A.

518.2

6987. A table of $\sqrt{(\frac{1}{2}\pi)}e^{\frac{1}{2}i\pi\rho^2}\int_\rho^\infty e^{-\frac{1}{2}i\pi\lambda^2}d\lambda$ **for complex values of** ρ. P. C. CLEMMOW AND C. A. MUNFORD. *Philos. Trans A*, **245**, 189–211 (*No.* 895, 1952).

In the theory of wave propagation the above function has applications for which ρ may be complex within a certain range of argument. Tables of the real and imaginary parts of the function are given to four decimal places, for values of $|\rho|$ from 0 to 0·80 at intervals of 0·01, and for values of arg ρ from 0° to 45° at intervals of 1°. A.

518.2

6988. Tables of Coulomb wave functions. Volume I. G. BREIT (Foreword and applications). M. ABRAMOWITZ (Introduction). *Nat. Bur. Stand., Appl. Math. Ser. No.* 17, 141 *pp.* (1952).

These are solutions of the radial Schrodinger wave equation with a Coulomb potential $F'' + [1 - 2\eta/\rho + L(L+1)/\rho^2]F = 0$. They extend the scope and accuracy of earlier tables to enable better calculations of quantum calculations such as disintegration probabilities and the anomalous scattering of charged particles when there are other interactions than the

Coulomb force. Other applications: the scattering of light nuclei; correlation experiments; the properties of the compound nucleus. The regular solution is tabulated to 7 decimal places to enable interpolation with regard to the radial distance ρ. Derivatives with respect to η are also given for interpolation with respect to it. This accuracy also helps when using recurrence relations to obtain extra solutions for other values of the angular momentum L and the irregular solutions. Table I: Values of $\Phi_L \propto \rho^{-(L+1)} F_L(\eta, \rho)$ and η-derivatives for $\eta = -5(1)5$; $L = 0(1)5$, 10, 11, 20, 21; $\rho = 0(\cdot 2)5$. Table II: Real part of

$$[\Gamma'(1 + i\eta)/\Gamma(1 + i\eta)]$$

$\eta = 0$ (·005) 2 (·01) 6 (·02) 10 (·1) 20 (2) 60 (·5) 110 to 10 decimals. Table III: Values of arg $\Gamma(1 + i\eta)$, $\eta = 0$ (·01) 1 (·02) 3 (·05) 10 (·2) 20 (·4) 30 (·5) 85 to 8 decimals. Table IV: Values of $C_0(\eta) = (2\pi\eta)^{\frac{1}{2}}(e^{2\pi\eta} - 1)^{-\frac{1}{2}}$ (a normalizing factor), $\eta = 0$ (·01) 5 (·05) 10, to 8 significant figures. Tables II and III include modified second central differences. G. J. KYNCH

518.5

6989. A planimetric method of harmonic analysis. F. B. DANIELS. *Rev. Sci. Instrum.*, **23**, 369–70 (*July*, 1952).

A method of harmonic analysis is described which requires only a planimeter and a set of ruled grids. An approximate value of a sine or cosine coefficient is obtained from a single tracing of the plotted function and the accuracy may be improved by means of correction terms obtained from higher order harmonics. The error resulting from the neglect of the correction terms is less than in the Fischer–Hinnan method. A.

518.5 : 621.318.572

6990. Digital computers at Manchester University. T. KILBURN, G. C. TOOTILL, D. B. G. EDWARDS AND B. W. POLLARD. *Instn Elect. Engrs Paper* 1362, 14 *pp.* [*Early Proof Issue*].

A new universal high-speed digital computing machine is described. It has a high-speed storage capacity of 10 240 binary digits and an intermediate storage capacity of over 280 000 binary digits. Its other features include a completely automatic transfer system between the two types of store; a B-tube which allows instructions to be modified in a much shorter time than by normal accumulator use, thus facilitating the programming of iterative processes; and a fast multiplier which carries out a multiplication in the same order of time as the normal addition or subtraction operations. Input and output operations in this machine utilize normal 5-hole teleprinter tape. Input is by way of a photoelectric reader and output can occur either from a tape punch or a teleprinter, or both can operate together. The method of maintenance and also some reliability figures are given. A.

519.54

6991. Transforms for the eddy-diffusion of clusters. L. F. RICHARDSON. *Proc. Roy. Soc. A*, **214**, 1–20 (*Aug.* 7, 1952).

Fresh interest in the "distance-neighbour function" has been aroused partly by the recent observations of Stommel, who found that the diffusivity for neighbours varied as the $\frac{4}{3}$ power of their separation on the sea, the same law that L. F. Richardson had noticed in 1926 in the atmosphere; and partly also by a rather similar law which has been deduced by Weizäcker and by Bachelor from the theory of isotropic turbulence, started by Kolmogoroff in 1941. Some doubt has hitherto persisted as to the circumstances in which a given distance-neighbour function could determine the distribution of diffusing particles in space. A recent objection by Ichiye is shown to be ill-founded. The obscurities almost all disappear when the distribution of the diffusing particles is analysed into an odd and an even function of the co-ordinate, and when the distance-neighbour functions of the odd and even parts are formed separately. Definite transformations are then available forward and backward. The manner of diffusion of the distance-neighbour function of the odd part is not fully known. The inquiry concerning it has been reduced to instructions to future observers of fluids in large volumes. For the even part an observational test is proposed. Wind tunnels are not considered. A.

ASTRONOMY . ASTROPHYSICS . GEODESY 52

522.61

6992. A two-plate catadioptric system for astronomical photography. P. A. WAYMAN. *Mon. Not. Roy. Astron. Soc.*, **112**, 18–20 (*No.* 1, 1952).

It is shown that a two-plate aplanatic optical system with a single spherical mirror can be designed to give good images over a considerable field and with a smaller tube-length than is used in the classical Schmidt camera. Alternatively, an anastigmatic design with a non-spherical mirror is possible. A.

523.16 : 536.25 : 551.513

6993. Convection under terrestrial and astrophysical conditions. S. CHANDRASEKHAR. *Publ. Astron. Soc. Pacific*, **64**, 98–104 (*June*, 1952).

A critical review of the phenomena of cellular convection in fluids, with particular reference to the inhibiting action of an external magnetic field on the onset of convection by thermal instability in an electrically-conducting fluid. D. B. BARBER

523.165

6994. The distribution of the discrete sources of cosmic radio radiation. B. Y. MILLS. *Aust. J. Sci. Res. A*, **5**, 266–87 (*June*, 1952).

The galactic distribution of 77 discrete sources of cosmic radio radiation has been examined. It is found that the distribution can be explained on the assumption that there are two major classes of source, one having a high degree of galactic concentration and the other having a random distribution. The possible identification of the sources with various types of astronomical object is discussed, and it is concluded that, although some of the evidence is suggestive, it is insufficient for any positive conclusions to be formed. A.

523.4

6995. Formation of planets and satellites. L. SINGH. Letter in *Sci. Cult.*, **17**, 442 (*April*, 1952).

On the assumption that the total mass of material condensed into satellites by accretion of matter in the vicinity of the parent body can be expressed by the relation $M = M_0/9^p \cdot n^2$ (where M_0 is primary mass, and p, n are order, and number of condensations respectively), total masses of (i) planets of the solar system; and (ii) the planetary satellites, are computed, and found to be in close agreement with the observed quantities. D. B. BARBER

523.4

6996. Recurrence of planetary orbits. I. Distance from sun. L. SINGH. Letter in *Sci. Cult.*, **17**, 525–7 (*June*, 1952).

The planets are divided into two groups on the basis of the relationship between their diameters and distances. These groups are then associated with Groups O and I of Mendeleef's periodic table, whence it is found that the mean distances are given approximately by the product of the atomic number of the corresponding element and the mean of the mean distances of Mercury and Venus. M. W. OVENDEN

523.5

6997. The velocity distribution of sporadic meteors. I. M. ALMOND, J. G. DAVIES AND A. C. B. LOVELL. *Mon. Not. Roy. Astron. Soc.*, **111**, 585–608 (*No.* 6, 1951).

The radio-echo diffraction technique was used to measure the velocities of sporadic meteors. Directional aerial systems enabled a selection to be made of meteors whose paths lie in great circle planes through either the apex or antapex of the Earth's way. The velocity distributions measured during three separate experiments, made between 1948 and 1950, are compared with the theoretical distributions, calculated on the assumption that the meteors are moving in random directions at the parabolic velocity limit. There is no evidence for a significant hyperbolic velocity component. The methods which enable the magnitude range of the meteors to be estimated are described and it is concluded that the results refer to meteors down to the fifth magnitude. There is no change in velocity distribution with meteor magnitude down to this limit. A.

523.5

6998. The velocity distribution of sporadic meteors. II. M. ALMOND, J. G. DAVIES AND A. C. B. LOVELL. *Mon. Not. Roy. Astron. Soc.*, **112**, 21–39 (*No.* 1, 1952).

Pt I was extended to fainter meteors. The results are similar and give no evidence for a significant hyperbolic velocity component. A fuller discussion of the magnitude range is given and it is concluded that the majority of meteors in these new experiments were probably in the magnitude range 6·0 to 7·5. A.

523.75

6999. The electrical conductivity in the solar atmosphere. D. E. OSTERBROCK. *Phys. Rev.*, **87**, 468–70 (*Aug.* 1, 1952).

The conductivity is computed from the physical properties of the solar material. It is shown that as a consequence of the high abundance of H the mean free paths of the free electrons are determined by collisions with neutral H atoms and not by collisions with the much less abundant ions. Furthermore, for magnetic fields less than about 750 gauss the curvature of the trajectories of the free electrons is small enough for the ordinary Ohm's law to be a good approximation. A.

523.77

7000. Studies of Hα line profiles in prominences. M. T. CONWAY. *Mon. Not. Roy. Astron. Soc.*, **112**, 55–72 (*No.* 1, 1952).

An account is given of observations made on quiescent prominences in the Hα line with the combined spectrograph and spectrohelioscope at the Royal Observatory, Edinburgh. Prominences were photographed in emission on the limb and in absorption on the disk. Corrections were determined and applied for the effect of grating ghosts, scattered light and limited resolving power. The average corrected intensity for prominences observed in emission on the limb was 10·4% of the continuous spectrum of the centre of the Sun's disk 13 Å outside Hα. The half-width of the Hα emission line ranges between 0·64 and 1·30 Å. A.

523.83

7001. Contribution to the study of the distribution of stellar velocities. II. J. DELHAYE. *Bull. Astron. [Paris]* **16**, 221–61 (*No.* 3, 1952) *In French.*

In continuation of the work described in the previous memoir [Abstr. 3289 (1951)] and based on Schwarzschild's method of analysing stellar proper motions, the "method of dispersions," due to Blaauw (1939), has been applied to the observational material utilized previously to provide comparative results that are largely independent of the former values. The precision of the two methods is similar; and, for the A-type stars, the two sets of parameters defining the ellipsoid of velocities agree satisfactorily. For types F and K, however, the two methods yield different values of the parameter, L, the longitude of the vertex of the ellipsoid. The differences are 15°·2 and 8°·4 respectively, and the obsd. deviation may provide an explanation of the observation that the solar velocity relative to A–F stars is smaller than that relative to K-stars. D. B. BARBER

523.872

7002. On emission lines in stellar spectra. I. W. BUSBRIDGE. *Mon. Not. Roy. Astron. Soc.*, **112**, 45–54 (*No.* 1, 1952).

Conditions are investigated for the formation of absorption lines when the fraction ξ of the line absorption coefficient l_ν is due to absorption and the fraction $1 - \xi$ is due to scattering, continuous absorption and continuous isotropic scattering being taken into account when estimating the flux of continuous radiation. It is shown that if $\xi < \lambda_c = \kappa_\nu/(\kappa_\nu + \sigma)$ the line must be dark, but that if $\xi > \lambda_c$ the line may be bright. The case $\xi = 1$, in which the line is formed by pure absorption, is considered in detail. It is shown that the line will be bright if $f(\lambda_\nu, \beta_\nu) > f(\lambda_c, \beta_\nu)$, where $f(\lambda, \beta)$ is a certain function, $\lambda_\nu = (\kappa_\nu + l_\nu)/(\kappa_\nu + \sigma + l_\nu)$, and β_ν is a constant depending on the constitution of the star and the frequency ν considered. Some numerical examples are discussed. A.

523.872

7003. On the determination of the size of the Balmer discontinuity by the photometric method through filters. D. BARBIER. *Ann. Astrophys.*, **15**, 113–26 (*No.* 2, 1952) *In French.*

Using the ultraviolet, blue and green measures made by Stebbins and Whitford in their six-colour photometry, the author calculates the size of the Balmer discontinuity for 129 stars. The discontinuity has been derived by the spectroscopic method for 48 of these stars and a comparison shows satisfactory agreement, taking into account the errors of observation. The variation of the discontinuity with spectral type is discussed and one or two results for outstanding stars are specifically mentioned.

E. G. MARTIN

523.872

7004. Researches on the continuous spectra of stars. D. CHALONGE [142–43]; A. BAILLET, D. CHALONGE AND J. COJAN [144–50]; D. CHALONGE AND M. SERVIGNE [151–53]; M. LAFFINEUR [154–6]. *Ann. Astrophys.*, **15**, 142–56 (*No.* 2, 1952) *In French.*

Describes a spectrograph and accessories for use at the Cassegrain focus of a telescope, especially for spectrophotometry of the continuum. Details are given of the 2-prism quartz spectrograph, with a novel method of widening the spectra by small oscillations of the plateholder about a point in the extreme end of the spectrum, thus giving greater width at the red than at the u.v., and thereby increasing the effective intensities at short wavelengths relative to the longer (Pt II). The terrestrial light source for comparison (giving a good continuous spectrum over the region 3000 to 6500 Å) is a layer of fluorescent minerals excited by a Hg lamp (Pt III), the current through which is kept constant by a specially designed electronic regulator (Pt IV). D. L. EDWARDS

523.873

7005. The classification of stars of early spectral types. D. CHALONGE AND L. DIVAN. *C.R. Acad. Sci.* [*Paris*] **234**, 2343–5 (*June* 9, 1952) *In French.*

The graphical method proposed consists in plotting two parameters for each stars, viz. λ_1, D, defined as the position, and amplitude of the Balmer drop. The method is tested by use of the data derived from measures of 123 stars [Barbier and Chalonge (1941)]. Spectral type and luminosity are given by the Yerkes classification. It is claimed that the procedure is superior to the orthodox visual method of classification. D. R. BARBER

523.877

7006. Absorption of radiation by an atmosphere of H, H^+ and H_2^+—semi-classical treatment. D. R. BATES. *Mon. Not. Roy. Astron. Soc.*, **112**, 40–4 (*No.* 1, 1952).

Calculations are carried out on the absorption of an atmosphere of H, H^+ and H_2^+ using the accurate quantal dipole moment but treating the nuclei as classical particles. Absorption coefficients are tabulated for wave numbers between 500 cm^{-1} and 26 000 cm^{-1}, and for temperatures between 2500°K and 12 000°K. The relative importance of bound-free and free-free transitions is also determined. A.

523.877

7007. Remarks on the evolution of stars. II. On a possible cause for the ejection of matter. E. SCHATZMAN. *Ann. Astrophys.*, **15**, 126–33 (*No.* 2, 1952) *In French.*

For Pt I, see Abstr. 5463 (1950). It is suggested that continuous ejection may arise from the instability of progressive waves which move toward the surface of the star. Illustrative calculations of amplitude factors are made for plane waves.

R. A. NEWING

523.877

7008. On the internal constitution of relativistically degenerate stars. M. RUDKJØBING. *K. Danske Vidensk. Selsk. Mat.-fys. Medd.*, **27**, 12 *pp.* (*No.* 5, 1952).

An extension of Chandrasekhar's theory of white-dwarf stars (1939) takes into account relativistic "spin-orbit interaction" in addition to the relativistic relation between particle energy and momentum. On substituting in the modified equations values of the natural constants adopted by Chandrasekhar, it is found that central densities are the same as for Chandrasekhar's earlier model when using the same parameter values, whilst for the same mass the radius of the new model is smaller. For the same value of $(1/y_0^2)$ the mass-radius relationship shows the masses to be smaller, and the radii larger than those obtained by Chandrasekhar. D. R. BARBER

525.35

7009. New theoretical investigation of crust tides and latitude variations. P. J. MELCHIOR. *Bull. Géod.*, *No.* 23, 59–66 (*March*, 1952) *In French.*

Fresh results are obtained for the polar movement. These are based upon a new method of analysis which relies upon the existence of a resonance effect depending upon the value of Chandler's period and acting upon the annual component. The constancy of the orientation of the axes of the annual elliptic component, and the agreement in phase between the annual variations in the Earth's rotation and the annual component of the polar movement are demonstrated. Explanations are suggested for the variations in the amplitude and the period of "free" movement in terms of the interference of two components attributed, respectively, to the Earth's interior and crust. A new relation is given connecting the Love number k and h. A.

525.35

7010. Irregularity of the rotation of the earth in the two hemispheres. A. STOYKO. *C.R. Acad. Sci.* [*Paris*] **234**, 2258–9 (*June* 4, 1952) *In French.*

From a study of meridian observations at a number of observatories in N. and S. latitudes over the period 1934–49, it is concluded that the seasonal fluctuation of the earth's rate of rotation is the same for both hemispheres, i.e. different points on the terrestrial surface preserve their relative positions during each rotation. D. R. BARBER

525.35

7011. New analysis of the Chandler movement. K. LEDERSTEGER. *Bull. Géod.*, *No.* 23, 67–71 (*March*, 1952) *In German.*

The Chandler movement is essentially an oscillation having an assumed period of the order of time of a

double revolution of the moon's nodes. The variation in its period is only apparent and relies upon a sudden change of phase which occurred at the beginning of 1928. If attention is paid to the residuals, a secondary oscillation with an 11-year period can be detected. This explains the Witting perturbations, and is possibly connected with the sun-spot cycle. A.

525.622

7012. Terrestrial tides of a heterogeneous fluid globe. G. JOBERT. *Ann. Geophys.*, **8**, 106–11 (*No.* 1, 1952) *In French.*

Using the calculations of P. Melchior (1950), it is shown that the effect of the heterogeneity of the earth is an increase of δ-parameter for the terrestrial tides (δ : ratio of the observed amplitude to that theoretically calculated for an unyielding earth). The demonstration is valid when the earth behaves as a fluid mass during the deformations; this does not hold for short-period tides, but can be taken as a fairly good approximation for long-period tides. The calculation is extended to the case where the density function has a finite number of discontinuities. A.

526.17

7013. A remark on the undulation of the geoid. E. MILKUTAT. Note in *Z. Naturforsch.*, 7a, 290 (*March–April*, 1952) *In German.*

The negative rate of change of undulation with height is equal to the relative gravity anomaly and the integral of relative anomaly taken along the normal to the geoid is everywhere a minimum. A. H. COOK

526.7

7014. The dynamic method in geodesy. L. BRAGARD. *Bull. Géod., No.* 23, 35–57 (*March*, 1952) *In French.*

The theory of the gravitational potential of a rotating body of fluid is developed and Stoke's formula giving the form of the geoid in terms of gravity anomalies is obtained. An inverse formula is deduced:

$$\Delta g = \frac{G_m}{a_m S}\int_S f_1 \Delta r dS$$

in which Δg is the gravity anomaly, G_m is equatorial gravity, a_m the equatorial radius, S the surface area of a sphere of radius a_m, Δr the elevation of the geoid and $f_1 = 1 - \frac{1}{4}(\sin \psi/2)^{-3}$. A. H. COOK

526.72

7015. The free-air reduction of gravity to the second order. H. JEFFREYS. *Mon. Not. Roy. Astron. Soc., Geophys. Suppl.*, **6**, 316–17 (*May*, 1952).

A definition of height is given in terms of the geopotential that will agree to the second order with the height determined by direct measurement along the vertical where such measurement is possible. The free-air reduction of gravity is carried to the second order so as to permit allowance for terms in eh and h^2. A.

PHYSICS 53

53.081 : 621.3.081

7016. Transcription of electrodynamic relations into different systems. H. PELZER. *Rep. Brit. Elect. Res. Ass., Ref. L/T261*, 15 *pp.* (1951).

For many years it will remain necessary to use simultaneously sources of literature written in a variety of electric systems. The main problem is not the one usually mentioned of converting the respective units but of converting the formulae and relations holding in one system into those holding in a different system. The present report is one proposal for making this easier. A.

53.087.4 : 621.317.755

7017. A high speed transient recorder. D. R. HARDY. *J. Sci. Instrum.*, **29**, 241–2 (*Aug.*, 1952).

Describes how the design of a high-speed oscillograph may be modified to produce a near-linear recordable sweep of 10^{-8} sec duration. The techniques necessary to reproduce photographically single transients of this order are discussed. A.

FUNDAMENTALS 530.1

530.12

7018. The Einstein connection of the unified theory of relativity. V. HLAVATÝ. *Proc. Nat. Acad. Sci. [Wash.]* **38**, 415–19 (*May*, 1952).

Null geodesics of the general theory are identified with minimal self-parallel curves of the Γ-connection, and the equations g_{ik}; $l = 0$ are solved for the $\Gamma_{\lambda\mu}$. The conditions to be imposed on the Γ's [Abstr. 5517 (1952)] are introduced and are shown to be mutually compatible in the case of an assumed simple form for the g_{ik}. Physical interpretations are suggested for various expressions arising in the theory. R. A. NEWING

530.12

7019. Theory of an experiment of Dufour and Prunier. A. METZ. *Rev. Opt. (Théor. Instrum)* **31**, 341–3 (*July*, 1952) *In French.*

Deals with an experiment using Sagnac's apparatus with fixed refracting tubes in the light beam which follows the rotation of the disk. Computation shows that the effect observed (displacement of the interference fringes) depends on the shape of the tubes. With the apparatus used by the authors, the displacement is n times that in Sagnac's experiment, n being the refractive index of water. [See also Abstr. 6272–4 (1952)]. A.

530.12

7020. Derivation of the mass-energy relation. H. E. IVES. *J. Opt. Soc. Amer.*, **42**, 540–3 (*Aug.*, 1952).

The mass equivalent of radiation is implicit in Poincaré's formula for the momentum of radiation, published in 1900, and was used by Poincaré in illustrating the application of his analysis. The equality of the mass equivalent of radiation to the mass lost

by a radiating body is derivable from Poincaré's momentum of radiation (1900) and his principle of relativity (1904). The reasoning in Einstein's 1905 derivation, questioned by Planck, is defective. He did not derive the mass-energy relation. A.

530.12

7021. Quantization of Einstein's gravitational field equations. II. F. A. E. PIRANI, A. SCHILD AND R. SKINNER. *Phys. Rev.*, **87**, 452–3 (*Aug.* 1, 1952).

Explicit expressions are obtained for all the constraints which appear in the canonical formulation of the field equations of general relativity and of electrodynamics. [For Pt I, see Abstr. 72 (1951)]. See also Abstr. 847 (1951). A.

530.145

7022. A question on the role of the quadratic metric in physics. C. F. v. WEIZSÄCKER. Note in *Z. Naturforsch.*, **7a**, 141 (*Jan.*, 1952) *In German.*

Following the possible foundation for the quadratic metric, proposed by Helmholtz and Weyl, it is considered whether this should include similarly the metric of the space of quantum states. R. H. DALITZ

530.145

7023. The correspondence approach to the quantum theory of wave fields. H. VOLZ. *Z. Naturforsch.*, **7a**, 70–5 (*Jan.*, 1952) *In German.*

The commutation relations in the quantum theory of wave fields are here obtained by an argument analogous to that of Heisenberg for particle mechanics. However, in the Fermi–Dirac case, this correspondence procedure is not able to obtain all the necessary relations. R. H. DALITZ

530.145

7024. The quantum theory of interacting gravitational and spinor fields. B. S. DEWITT AND C. M. DEWITT. *Phys. Rev.*, **87**, 116–22 (*July* 1, 1952).

A brief treatment of spinors in general co-ordinates is given. The mathematical results are used to derive the Hamiltonian for a spinor field interacting with the gravitational field. The Hamiltonian formulation follows a method developed by Dirac, which has been used by Pirani and Schild to treat the free gravitational field. The Dirac method is further used here to carry out a reduction of the Hamiltonian to a form suitable for quantization. The quantization procedure is actually given, and the problems arising in connection with it—such as the factor ordering ambiguity and the vacuum expectation value of the spinor stress density—are discussed. A.

530.145

7025. On the harmonic oscillator with changed commutator. P. JAUHO. *Ann. Acad. Sci. Fennicae*, *A*1, *No.* 110, 6 *pp.* (1952).

It is shown that the problem of a harmonic oscillator with changed commutation relation [Abstr. 4701 (1950)] is conveniently treated with the symbolic method. The present problem is very analogous to the problem of the usual harmonic oscillator; especially the energy level differences and the selection rules remain the same. In the zero point energy and in the matrix elements q_{nm} there are ambiguities due to the undetermined parameter λ_0, which is restricted only by the condition $0 \leqq \lambda_0 < \hbar\omega$. A.

530.145 : 536.7

7026. On the thermodynamics of wave fields. A. E. SCHEIDEGGER AND C. D. MCKAY. *Canad. J. Phys.*, **30**, 117–18 (*March*, 1952).

It is shown that the thermodynamic functions cannot be defined for a non-quantized field theory in the usual way; i.e. if there exists a partition function in Gibbs' sense at all, $Z = \int \exp(-\theta H)\, d^{2N}\Omega$ is certainly not the correct one. A.

530.145

7027. Excited states of a particle in a field. S. V. TYABLIKOV. *Dokl. Akad. Nauk SSSR*, **81**, 31–3 (*No.* 1, 1951) *In Russian.*

Spinless particles in a scalar field for the case of adiabatic binding are investigated. If the particle is strongly bound the effective mass, due to the field, may greatly exceed that of a non-interacting particle. Furthermore excited states arise due to the appearance of a moment of the particle caused by the field. J. JACOBS

530.145

7028. On the question of the fundamental equations of relativistic quantum field theory. N. N. BOGOLYUBOV. *Dokl. Akad. Nauk SSSR*, **81**, 757–60 (*No.* 5, 1951) *In Russian.*

Considerations of covariance show that it suffices to consider the wave vector as functional of spatially similar hypersurfaces. This wave vector satisfies the fundamental wave equations and allows expressions to be determined for the components of impulse and momentum. To have physically interesting cases it is necessary that the operator representing transformations of the wave vector from one hypersurface to another should exist. J. JACOBS

530.145

7029. On a class of fundamental equations of relativistic quantum field theory. N. N. BOGOLYUBOV. *Dokl. Akad. Nauk SSSR*, **81**, 1015–18 (*No.* 6, 1951) *In Russian.*

Mathematical. A more general procedure is adopted to avoid the divergence usually encountered. The divergence due to insufficiently rapid decrease of the integrand functions in the representation of impulse is removed by a regularization process which retains the gradient-invariance. J. JACOBS

530.145

7030. On the energy-momentum tensor of classical field theories. A. SCHOCH AND H. STEINWEDEL. *Z. Naturforsch.*, **7a**, 66–70 (*Jan.*, 1952) *In German.*

The energy-momentum tensor of classical vector and scalar fields is investigated. It is found that, in order that the divergence of this tensor should vanish when charge is present, the first regularization postulate of Pauli and Villars [Abstr. 47 (1950)] must be satisfied. R. H. DALITZ

530.145

7031. Difficulties of March's theory of a universal length. G. EDER. *Acta Phys. Austriaca*, **5**, 461–76 (*No.* 4, 1952) *In German.*

It is claimed that it is not possible to ensure Lorentz invariance in a suitable manner, that predictions of the theory are not in agreement with experiment and that zero-point energy divergence difficulties are not removed. R. A. NEWING

530.145

7032. Thermodynamic vacuum fluctuations of wave fields. A. E. SCHEIDEGGER AND C. D. MCKAY. *Phys.*, 132, 179–82 (*No.* 2, 1952) *In German.*

Following methods of the authors' earlier work [Abstr. 6732 (1951)] an expression is obtained for thermodynamic vacuum fluctuations of a wave field. The production of elementary particles by thermal fluctuations of the particle fields is shown extremely improbable. R. H. DALITZ

530.145 : 535.43 : 534.26

Scattering by obstacles with spherical and circular cylindrical symmetry. *See Abstr.* 6350

530.145

7033. "Runaway solutions" and quantum electrodynamics. H. STEINWEDEL. Note in *Z. Naturforsch.*, **7a**, 292–3 (*March–April*, 1952) *In German.*

Runaway solutions in classical electrodynamics are not expansible in powers of the charge e: the case of an electron bound harmonically exemplifies this. It is not yet clear whether runaway solutions exist in quantum electrodynamics, since only solutions in powers of e are at present obtained. [See also Abstr. 4142 (1952)]. R. H. DALITZ

530.145

7034. A perturbation method for Dirac's new electrodynamics. M. CINI. *Proc. Roy. Soc. A*, **213**, 520–9 (*July* 22, 1952).

The fundamental equations of Dirac's new classical electrodynamics cannot be solved with the conventional perturbation method because there is no possibility of setting the coupling constant e equal to zero to start with. A perturbation method is worked out under the assumption that the charge is small, which means that the field created by the charge is neglected in the zero-order approximation. A general solution for the case of irrotational flow and another one for small vorticity are given. The equations derived are not easily soluble for large vorticity. A.

530.145

7035. Quantum electrodynamics in the reciprocity formulation. I. RAĬSKIĬ [J. RAYSKI]. *Zh. Eksper. Teor. Fiz.*, **22**, 194–9 (*No.* 2, 1952) *In Russian.*

A formulation of the theory of a non-local spinor field according to the ideas of Born and Yukawa. Coupling with the radiation field is discussed in terms of the S-matrix and the analogy with the corresponding local theory is demonstrated. The problem of self-energies is discussed with reference to theories with mixtures of compensating fields (Pais, 1947).

W. J. SWIATECKI

530.145

7036. Report on the recent development of quantum electrodynamics. I. K. BAUMANN. *Acta Phys. Austriaca*, **5**, 544–58 (*No.* 4, 1952) *In German.*

An exposition of the Schwinger theory of mass-charge renormalization. R. A. NEWING

530.145 : 539.153

Effect of electromagnetic radiation on the Lamb shift. *See Abstr.* 7486

530.145

7037. On the theory of multiple scattering of charged particles. G. MOLIÈRE AND F. SAUTER. *Z. Naturforsch.*, **7a**, 280–2 (*March–April*, 1952) *In German.*

Some remarks on the investigation of Sauter and Wauke [Abstr. 5545 (1952)], clarifying this and relating it to previous calculations. R. H. DALITZ

530.145

7038. The gauge invariance problem. H. S. SNYDER. Letter in *Phys. Rev.*, **87**, 164 (*July* 1, 1952).

The vector basis used by Schwinger for the interaction representation is chosen independently of the gauge. However, these vectors represent different physical states in different gauges, whence it is concluded that Schwinger's scheme is actually gauge-dependent. R. H. DALITZ

530.145

7039. The enumeration of graphs in the Feynman–Dyson technique. C. A. HURST. *Proc. Roy. Soc. A*, **214**, 44–61 (*Aug.* 7, 1952).

As an aid to practical calculations, and as a first step in determining whether field theories that can be renormalized lead to convergent perturbation expansions, the number of graphs that can be drawn for each stage of approximation is investigated. Using the idea of a normal product of operators, a simple method is given for finding the number of Feynman–Dyson graphs, with n vertices, that can be drawn when the interaction Hamiltonian density is of a general type. By solving a difference equation approximately, it is shown that the number of graphs remaining after the removal of those containing subgraphs of a specified type is asymptotically equal to the total number of unmodified graphs. Also it is shown that the number of graphs that can be drawn with n vertices increases very rapidly with n, no matter how many external lines are present, and this rapid increase still occurs even when the class of irreducible graphs alone is considered. Thus the perturbation expansions of field theory cannot converge unless the matrix elements decrease with correspondingly great rapidity as n increases. A.

530.145

7040. On the spin-orbit interaction of nucleons. V. P. SILIN. *Zh. Eksper. Teor. Fiz.*, **22**, 136–9 (*No.* 2, 1952) *In Russian.*

Starting from the Dirac–Fock–Podolski formalism the energy operator of the interaction of two nucleons is worked out in the order quadratic in the coupling, using neutral scalar and ps. scalar mesons with non-divergent interactions. Spin-orbit interactions appear. W. J. SWIATECKI

530.145

7041. Bremsstrahlung of electrons on electrons in the non-relativistic case. B. K. FEDYUSHIN. *Zh. Eksper. Teor. Fiz.*, **22**, 140–2 (*No.* 2, 1952) *In Russian.*

Exchange is taken into account. An estimate is also made of the energy loss due to this for an electron passing through matter, and is found to be at most a few % of the bremsstrahlung on nucleons.

W. J. SWIATECKI

530.145

7042. On a generalized law of interaction. D. I. BLOKHINTSEV. Letter in *Zh. Eksper. Teor. Fiz.*, **22**, 254 (*No.* 2, 1952) *In Russian.*

The assumption of a small but finite $x^2 - c^2t^2$ for

the propagation of signals (introduced by the author (1945–8) to preserve the linearity of field equations) leads to non-point-like interactions. W. J. SWIATECKI

530.145

7043. On the abbreviated theory of spin ½ particles. J. SERPE. *Physica*, **18**, 295–306 (*May*, 1952) *In French.*

It is shown that the unquantized two-component wave equations considered by Weyl (1929) are related to Majorana's abbreviated theory (1937) for $m = 0$ in almost the same way as the one-electron theory is related to the electron-positron theory. In a Fock two-component representation (configuration space method) a Majorana free particle (with $m = 0$) may be described by Weyl's equations or by their complex conjugates, according to its spin state. The two values of the spin play a role similar to that of the two values of the charge in the electron-positron theory. A.

530.145 : 537.12

7044. Dirac's new theory of the electron. M. BORN. Letter in *Nature* [*Lond.*] **169**, 1105 (*June* 28, 1952).

See Abstr. 981 (1952). Dirac's statement that a classical theory should involve only the ratio e/m is discussed in relation to the fact that scattering formulae involve the combination $m(e/m)^2$. It is suggested that future theories should involve the introduction of an absolute length and the simultaneous consideration of meson and electromagnetic fields.

R. A. NEWING

530.145

7045. On the production of particles in fast nucleon collisions. E. L. FEĬNBERG AND D. S. CHERNAVSKIĬ. *Dokl. Akad. Nauk SSSR*, **81**, 795–8 (*No.* 5, 1951) *In Russian.*

By considering the Fourier decomposition of the meson field surrounding a relativistic nucleon an attempt is made to improve Fermi's statistical theory of high-energy collisions (1950). Difficulties associated with velocities of propagation $>c$, apparently necessary to establish thermal equilibrium along the transverse axis of the relativistically flattened nucleon are removed. W. J. SWIATECKI

530.145

7046. Non-linear terms in meson equations. W. E. THIRRING. *Z. Naturforsch.*, **7a**, 63–6 (*Jan.*); *Erratum*, 379 (*May*, 1952) *In German.*

The non-linear term $\lambda(\phi^*\phi)^2$ in meson field theory is shown, for a simple nuclear model, to lead to the saturation property for nuclear binding energies.

R. H. DALITZ

530.145

7047. Nonlinear pseudoscalar meson theory. E. M. HENLEY. *Phys. Rev.*, **87**, 42–6 (*July* 1, 1952).

An attempt is made to explain nuclear saturation by means of a non-linear pseudoscalar meson field. The same non-linearity as that introduced by Schiff for the scalar case is employed; the treatment follows similar lines, using classical field theory. The total source strength is calculated for an isolated nucleon at rest, and an expression for the two-nucleon interaction in free space is obtained. It is shown that both of these are infinite, so that a cut-off must be introduced. For the two-nucleon problem the variation method is used with a simple trial function, which is the superposition of the single-nucleon meson field amplitudes; this should be a good approximation for large separation of the nucleons. Then the non-linear terms of the two-particle interaction are shown to be separable from the linear ones, and are repulsive. The non-linear terms can also be separated in the many-body problem, but they are not necessarily positive definite here, and hence need not lead to saturation. A nuclear model, based on a lattice structure with stationary nucleons is discussed qualitatively. A.

530.145

7048. The influence of relativistic corrections upon singular nuclear potentials. J. WERLE. Letter in *Phys. Rev.*, **87**, 159–60 (*July* 1, 1952).

Solutions of meson equations by development of the wave functions according to successive orders of time derivatives analogous to Einstein and Infeld's successive approximations in relativity are outlined. The equivalence of ps. scalar and ps. vector couplings for ps. scalar mesons can be simply demonstrated. Spin-orbit coupling also follows. W. J. SWIATECKI

530.145

7049. The classical equations of motion of point particles. I. P. HAVAS. *Phys. Rev.*, **87**, 309–18 (*July* 15, 1952).

The problem of the relation of field theory and action at a distance is investigated for the neutral vector and scalar meson theories. The equations of motion of point particles with half-advanced, half-retarded interaction are found using the field theoretical methods developed for retarded interaction; they include an integral over the entire motion of the particle in analogy to an integral over the past motion in the retarded case. These are inadmissible from the point of view of action at a distance and a new set of equations is postulated. This new set is derivable from a variational principle analogous to Fokker's in electrodynamics for the symmetric case, and energy-momentum tensors guaranteeing the conservation laws can be defined. The application of the Wheeler–Feynman method to the equations of the symmetric case leads to the equations of the retarded case only for the field theoretical equations, but to slightly different ones for those of action at a distance. Some implications of these results are discussed. A.

530.145 : 537.533.74

7050. On higher Born approximations in potential scattering of fast electrons by atomic nuclei in a static field. S. N. BISWAS. *Indian J. Phys.*, **26**, 38–45 (*Jan.*, 1952).

Some of the conclusions on higher Born approximation following the works of Sauter, Sexl and Distel are incorrect. Mott, using the Dirac 2nd-order relativistic equation and taking the exact solution, has obtained a 2nd-order correction term, which is different from the result of Urban. Urban's result is the same as that of Sexl. Both results are incorrect as they are not consistent expansions in powers of αZ, where α and Z are the fine-structure constant and the atomic number respectively. Using the matrix-formalism, Dalitz has recently obtained a

nd-order term in the scattering cross-section for the Dirac particle [Abstr. 5125 (1951)], pointing out the errors in the development of the former writers. In his paper, the 2nd-order approximation in the elastic scattering of fast electrons by atom has been carried out using the hypercomplex notation. The first approximation has been checked by this method by Bauter. The method used here is based on a consistent expansion in powers of αZ. The series actually obtained for the cross-section is given by,

$1 - \beta^2 \sin^2 \theta/2) + \pi\alpha Z\beta \sin^2 \theta/2 (\frac{3}{2} - 2 \sin^2 \theta/2) + \ldots$

multiplied by the Rutherford scattering formula. A.

530.162

7051. Mathematical study of the generalized Boltzmann equations. S. MARQUET. *C.R. Acad. Sci. Paris*] **234,** 2345–7 (*June* 9, 1952) *In French.*

A discussion of the relativistic and quantum equations is based on methods developed by R. Marrot [*J. Math.*, **25,** 93–159 (1946)]. R. A. NEWING

530.162

7052. The ergodic theorem in quantum statistical mechanics. M. J. KLEIN. *Phys. Rev.*, **87,** 111–15 (*July* 1, 1952).

An ergodic theorem is a statement of the equality of the time averages of the physical properties of a system and the averages of these quantities obtained from the consideration of a Gibbsian ensemble of identical systems. It is shown that, in quantum statistical mechanics, a necessary and sufficient condition for the existence of an ergodic theorem can be derived for a system in weak energetic interaction with its surroundings. This necessary and sufficient condition for the equality of time and (microcanonical) ensemble averages is that all operators invariant in time shall reduce to constant multiples of the unit operator when applied to the system itself. It is shown that the conditions for ergodicity are formally analogous to those derived by von Neumann for classical statistical mechanics. No assumption of "molecular chaos" is made. A.

530.162 : 530.145 : 536.7

Thermodynamic continuity and quantum principles. *See Abstr.* 7244

530.162 : 536.423.4

Statistical mechanical theory of irreversible condensation. *See Abstr.* 7222

530.162 : 536.71

Statistical theory of equations of state and phase transitions. *See Abstr.* 7246–7

530.162 : 537.3

7053. A note on "irreversibility and generalized noise." J. L. JACKSON. *Phys. Rev.*, **87,** 471–2 (*Aug.* 1, 1952).

The response of a dissipative system to a generalized driving force is calculated and an expression for the admittance is obtained. The expression for the conductance is in agreement with the expression obtained by Callen and Welton [Abstr. 6759 (1951)] and a new expression for the out-of-phase component of the admittance is obtained. A.

530.162 : 537.312.62

Statistical thermodynamics of the superconducting state. *See Abstr.* 7294

GENERAL MECHANICS . MECHANICS OF SOLIDS 531

531.224

7054. The bending of a semi-infinite strip. R. C. T. SMITH. *Aust. J. Sci. Res. A*, **5,** 227–37 (*June*, 1952).

An exact solution is obtained for the normal displacement of a thin semi-infinite strip subjected to arbitrary displacements and couples on the short edge but with the long edges clamped. It is expressed as a series in the characteristic functions of a matrix differential equation. A.

531.224.4

7055. A characteristic type of instability in the large deflexions of elastic plates. I. Curved rectangular plates bent about one axis. II. Flat square plates bent about all edges. D. G. ASHWELL. *Proc. Roy. Soc. A*, **214,** 98–118 (*Aug.* 7, 1952).

From a general equation governing the bending of thin elastic plates into certain types of surfaces of revolution expressions are derived in Pt I for the behaviour of rectangular plates with initial curvatures, subjected to pure bending about one axis. It is found that such plates exhibit the type of instability characteristic of thin-walled structures which depend for their stiffness on curvature. Curves are drawn showing the deformation suffered by such plates, and an expression for the critical bending moment at which instability occurs is obtained. Experimental results show satisfactory agreement. In Pt II the analysis is extended to deal with the case of flat square or rectangular plates loaded by distributed bending moments applied to all four edges. Curves are drawn to describe their behaviour, and they are found to exhibit the characteristic instability displayed by thin-walled curved structures. Experimental verification is satisfactory. A.

531.383

7056. The symmetrical spherical top. C. M. BRAAMS. Letter in *Nature* [*Lond.*] **170,** 31 (*July* 5, 1952).

The motion of a top, the cross-section of which consists of a hemisphere with stem, when spinning on a horizontal plane is discussed. The stem originally upwards moves away from the vertical until it touches the plane when the top quickly rises on the stem and continues to rotate in that stable position. A sphere consisting of two halves of different specific weight behaves similarly. The effect is due to the friction arising when the point of contact slides over the plane, the resulting torque causing the angular momentum vector to move over the surface of a curve with vertical axis. S. WEINTROUB

MECHANICAL MEASUREMENTS 531.7

531.717.3 : 621.317.39 : 620.172.222

7057. A four channel dynamic strain-recorder. C. H. G. MILLS AND J. R. BRISTOW. *J. Sci. Instrum.*, **29,** 253–6 (*Aug.*, 1952).

A 4-channel dynamic strain-recording instrument, for use with wire-resistance strain gauges in vehicles

on the road, is described. A.C. energized gauge bridges are used and the strain records are on 35 mm film, being photographed from 1½ in c.r.t's as an a.m. carrier wave. Insensitivity to shocks, which produce microphonic signals, has been obtained even over the roughest terrain by using frequency-selective amplifiers. A band-pass characteristic is achieved by the use of stagger-tuned parallel-T feedback networks. A.

531.717.8 : 535.417

7058. Thin-film interferometric techniques for high-magnification topographical studies. S. Tolansky and M. Omar. Letter in *Nature* [*Lond.*] **170**, 81–2 (*July* 12, 1952).

A technique is described for the examination of surface topography using interference fringes formed in a thin film of Canada balsam spread over the surface. These films appear to follow the contour of the lower surface whilst keeping a flat upper surface. No optical flat is required and hence short working-distance objectives with high resolution can be employed. Examples on crystal surfaces using both monochromatic and white light are illustrated.

D. G. AVERY

531.76 : 621.318.572 : 621.317.79

7059. The use of a pulse-height-analyzer for time interval measurements. G. Jenssen and A. Sunde. *Physica*, **18**, 265–9 (*April*, 1952).

A previously published analyser, having registered a pulse height by a count in the relevant channel, uses the next incoming pulse as a reset. The note explains a circuit modification which enables the time interval of two such pulses to be measured. A. J. KENNEDY

531.787

7060. A precision differential manometer. G. J. Maslach. *Rev. Sci. Instrum.*, **23**, 367–9 (*July*, 1952).

The requirements imposed by investigations of flow and heat transfer characteristics of low density gases have been met by developing a precision manometer for measuring pressures in the range from approximately 0·05 mm Hg to 20 mm Hg. The instrument makes use of optical elements to allow the observer to view a clear magnified image of the meniscus. Precision lead screws and gearing control the movement of the optical viewing systems, and together with a mechanical differential indicate the differential height on a counter directly in thousandths of an inch. The instrument employing a low vapour pressure oil can be operated and read rapidly, and the reproducibility of its readings by different observers is half its least count, or 0·001 mm Hg. A.

532.787.4 : 621.317.79

7061. Sensitive mercury-level detecting unit for manometers. W. E. Williams, Jr. *J. Res. Nat. Bur. Stand.* [*Wash.*] **48**, 54–8 (*Jan.*, 1952).

An electronic instrument has been developed to determine the differential height of the two arms of a mercury manometer [see *Electronics*, **20**, 172 (*Nov.*, 1947) and Abstr. 536 (1948)]. The instrument has a sensitivity corresponding to 0·0005-inch height differential and the pick-up units are designed to provide this performance at absolute pressures up to 35 000 pounds per square inch. Use is made of a high-frequency mutual-inductance micrometer, with the tops of the mercury columns serving as the reference surfaces. A.

531.792

7062. Improved method for lapping a dividing gear for a ruling engine. E. Leibhardt. *J. Opt. Soc. Amer.*, **42**, 447–50 (*July*, 1952).

A simple method has been developed for correcting errors in spacing worm gear teeth, by the use of three worms spaced at 120° intervals around the gear. The accuracy which has been attained by this method is primarily due to the sensitiveness of adjustment of end thrust bearings and the use of a supersensitive dial indicator in locating the positions where lapping should occur. Accuracy in the spacing of the teeth to within 0·0001 inch has been attained. The ease by which lapping can be controlled indicates that even greater accuracy can be attained by this method if need for such accuracy arises. A.

MECHANICS OF FLUIDS 532

532.13 : 532.73–2

7063. The viscosity of two-liquid systems in the critical region. V. K. Semenchenko and E. L. Zorina. *Dokl. Akad. Nauk SSSR*, **80**, 903–5 (*No.* 6, 1951) *In Russian.*

The viscosity of mixtures of (*a*) triethylamine and water, (*b*) nitrobenzene and hexane is found to increase suddenly by about 20% to produce a sharp maxm. at the critical temp. [approx. 18·2°C for mixture (*a*) and approx. 13·6°C for mixture (*b*)]. At this point also, the mixtures show a marked opalescence, which changes to a milky turbidity beyond the critical region. It is concluded that the first stage in the formation of a dispersed system is the appearance of microheterogeneities, and that under critical conditions of temp. and concentration, the degree of microheterogeneity is a maxm. The point of max. viscosity may thus be used to indicate the separation of the liquid into distinct phases. In this way solubility-temperature curves are produced for the above mixtures; these differ from those obtained by the vanishing-meniscus method, but it is claimed that maximum viscosity is a more reliable indicator of the coalescence of the two phases then is disappearance of the meniscus. A. SCHOFIELD

532.133

7064. Absolute viscosity of water at 20°C. J. F. Swindells, J. R. Coe, Jr and T. B. Godfrey. *J. Res. Nat. Bur. Stand.* [*Wash.*] **48**, 1–31 (*Jan.*, 1952).

The determination was made by the method of capillary flow. By means of a calibrated injector various known constant rates of flow were produced in capillaries of measured dimensions, and observations were made of the corresponding pressure drops through the capillaries. The effects of the ends of the capillaries were rendered negligible by the simultaneous treatment of data obtained with pairs of capillaries having essentially the same diameters but different lengths. The value found is 0·010019 poise as compared with 0·01005 poise, which has generally been accepted for the past 30 years. The estimated

curacy of the new determination is ±0·000003 se. As a result of this work, beginning on July 1, 52, the National Bureau of Standards is planning use the value 0·01002 poise for the absolute cosity of water at 20°C as the basis for the calibra- n of viscometers and standard-sample oils. It is commended that other laboratories adopt this value the primary reference standard for comparative asurements of viscosity. A.

532.133 : 539.132

65. Viscosity and molecular structure. G. M. NCHENKOV. *Dokl. Akad. Nauk SSSR*, **80**, 899–2 (*No.* 6, 1951) *In Russian.*

It is shown that when $\varepsilon_0 \gg RT$ (ε_0 = the molecular nding energy, R = gas. const., T = abs. temp.) the mp. dependence of the viscosity (η) of a liquid of nsity ρ is given by $\log \eta\rho^{-4/3}T^{-1/2} = \text{const.} + 2{\cdot}303RT$. This relation is used to determine ε_0 m measurement of η, ρ, T for (*a*) normal paraffins m C_5H_{12} to $C_{18}H_{38}$ and $C_{32}H_{66}$, (*b*) the normal ohols CH_3OH, C_2H_5OH, C_3H_7OH. It is found at ε_0 depends linearly upon mol. wt. M for normal raffins up to $C_{18}H_{38}$, the increase in binding energy r each additional CH_2-group being approx. 0 cals/mol; $C_{32}H_{66}$ has a relatively lower binding ergy, which is attributed to a transition from a near to a twisted chain structure in the higher raffins. A similar relation between ε_0 and M ists for the normal alcohols, but the increase in nding energy for each CH_2-group is approx. 0 cals/mol. The difference betw. the binding ergy per CH_2-group in paraffins and alcohols is tributed to polarization of the CH_2-group in ohols, induced by the presence of the hydroxyl oup. A. SCHOFIELD

532.137

66. The theory of an oscillating cylinder viscometer. I. A. A. K. IBRAHIM AND A. M. KABIEL. *J. Appl. Phys.*, **23**, 754–6 (*July*, 1952).

The theoretical distribution of velocity across a liquid (Newtonian) between two coaxial cylinders and the velocity gradient at the inner cylinder is calculated a new way. The equation used for calculating e coefficient of viscosity of the liquid is also given. he theory agrees with experiment for all values of $\theta_0/\phi_0 \leqslant 1/2$ (where θ_0 is the amplitude of deflection the inner cylinder and ϕ_0 is the amplitude of the cillations inexorably imposed on the outer cylinder). A.

532.51

67. Note on the velocity distribution over an elliptic cylinder submerged in a uniform flow of compressible fluid. M. KAWAGUTI. *J. Phys. Soc. Japan*, 313–15 (*May–June*, 1952).

The exact analytical expression, correct to M^4, for e velocity distribution over an elliptic cylinder hich is submerged in a uniform flow of a compressible fluid [Abstr. 8577 (1951)] is expanded in ascending powers of θ, the eccentric angle of the ellipse, in der to reduce the expression to a more tractable rm. Numerical values of coefficients of θ and θ^3 e given for various values of thickness ratio t nging from 0 to 1·0, and it is shown that the convergency of the M^2 expansion method is very good ar the stagnation point. A.

532.525

7068. On the recurrent figure of a jet. Y. WADA. *J. Phys. Soc. Japan*, **7**, 211–14 (*March–April*, 1952).

Introducing a small viscosity, a fundamental equation is obtained which gives the relation between the wavelength of standing surface waves of an infinitely long cylindrical flow and its common velocity. The graph of the first approximation shows that there is always a minimum velocity for the appearance of the waves of any assigned mode for any radius of the jet and that this minimum velocity is inversely proportional to the radius. The graph shows also that with increasing velocity, waves of successively higher mode are superposed and the surface becomes gradually ruffled. When the velocity is greater than the minimum value, the equation gives two wavelengths. The longer and shorter ones belong respectively to the waves occurring below and above the disturbance; this is investigated to the second approximation. A.

532.525

7069. Note on the discharge coefficient of a critical-flow nozzle. H. WISE. Letter in *J. Appl. Phys.*, **23**, 801 (*July*, 1952).

Variations in the discharge coefficient of gas flowing through a critical-flow nozzle, i.e. one in which gas flows under conditions of sonic velocity in the throat, have been attributed to impurities in the gas. Experimental results obtained, using 6 very different gases of very nearly the same percentage purity (97·0–99·9%), show that this explanation is inadequate; the effective throat area was found to vary with the molecular weight of the gas. The effect is attributed to the existence of a boundary layer in the nozzle, and it is shown that the ratio of the effective to the geometric throat area approaches 1 with increasing molecular weight and decreasing viscosity of the gas at a given temperature and pressure. Moreover the difference between the geometric and effective radius of the throat is proportional to $(\eta/M)^{1/2}$, η denoting the viscosity and M molecular weight of the gas.

J. S. G. THOMAS

532.527

7070. A type of non-homogeneous turbulent flow. J. BASS. *C.R. Acad. Sci.* [*Paris*] **234**, 2256–7 (*June* 4, 1952) *In French.*

The general structure and local form of the space-time correlations of the stationary (in time), turbulent flow of an incompressible fluid, non-homogeneous in one direction, λ, and homogeneous in directions normal to λ and characterized by symmetry of revolution about λ is discussed. The turbulence is essentially an extension of the axially symmetrical turbulence discussed by Batchelor [Abstr. 224 (1947)].

J. S. G. THOMAS

532.574

7071. Correcting for density and viscosity of incompressible fluids in float-type flowmeters. M. R. SHAFER, E. F. FIOCK, H. L. BOVEY AND R. B. VAN LONE. *J. Res. Nat. Bur. Stand.* [*Wash.*] **47**, 227–38 (*Oct.*, 1951).

The theory of the flow of incompressible fluids through float-type flowmeters is developed by the methods of dimensional analysis. The relations thus

derived have been verified experimentally for the specific cases of five flowmeter tubes with 11 liquid hydrocarbons of different physical properties. Parameters that are suggested to describe the performance of any float-type flowmeter may be evaluated by measuring the float density and the mass rate of flow of fluids of known density and viscosity. Procedures are described whereby, after calibration of a metering tube with a few fluids of known physical properties, accurate corrections may be calculated for any fluid whose properties lie within the range embraced by the calibration fluids. Application of the proposed method of calibration and correction to the five metering tubes studied gave corrected values of flow that were always within $\frac{1}{4}\%$ of the true values of flow. A.

532.593

7072. Edge waves on a sloping beach. F. URSELL. *Proc. Roy. Soc. A*, **214**, 79–97 (*Aug.* 7, 1952).

The set of eigenfrequencies of a mechanical system forms its spectrum. A discussion is given of systems with discrete, continuous and mixed spectra. It is shown that resonance occurs at discrete points of the spectrum, and at cut-off frequencies (end-points of the continuous spectrum). The motion in a semi-infinite canal of finite width closed by a sloping beach has a mixed spectrum. The inviscid theory predicts that at a discrete frequency the resonance is confined to the neighbourhood of the beach (inviscid edge wave), while at a cut-off frequency the resonance extends a long way down the canal. The latter resonance is confined to the neighbourhood of the beach (viscous edge wave) by viscosity which is important near a cut-off frequency. Especially large resonances are predicted for a series of critical angles, of which the largest is 30°. The theory is verified experimentally in the frequency range 100 to 17 c/min for the angles 37·6 and 29·5° A.

CAPILLARITY 532.6

532.612.4 : 530.162

7073. The influence of differences in molecular size on the surface tension of solutions. IV. I. PRIGOGINE AND J. MARECHAL. *J. Coll. Sci.*, **7**, 122–7 (*April*, 1952).

The statistical calculation of the surface tension of solutions containing two sorts of molecules, one occupying θ sites and the other one site, has been carried out for a simplified model in which only configurations of the molecules parallel to the surface are taken into account. For this model, it is possible to deduce very simple explicit formulas, which are used for a qualitative discussion of the surface tension of polymer solutions. A.

532.613.4 : 541.182.4

7074. Time-dependence of boundary tensions of solutions. IV. Kinetics of adsorption at liquid-liquid interfaces. A. F. H. WARD AND L. TORDAI. *Rec. Trav. Chim. Pays-Bas*, **71**, 572–84 (*May*, 1952).

For Pt III, see Abstr. 4943 (1952). Various mechanisms are considered which might explain the variation of interfacial tensions with time, when fatty acids are adsorbed from hexane on to a hexane/water interface. In these solutions there are both single and associated molecules of the fatty acids. Although the single molecules are the adsorbable species, it is shown that the slow adsorption cannot be attributed to their relative scarcity. The Langmuir adsorption isotherm is found not to apply accurately at equilibrium, and a new isotherm is proposed. A mechanism is suggested to explain the kinetics of adsorption and desorption and is found to be in accordance with the experimental variation of interfacial tension with time. Velocity constants for adsorption (k_1) and desorption (k_2) are evaluated. The resulting equilibrium constants (k_1/k_2) are found to agree well with equilibrium constants deduced thermodynamically by an entirely independent process. The effect of temperature on the processes of adsorption and desorption is also discussed. A

532.614.2 : 536.421.

7075. Surface tension and melting point. B. DAYAL. Letter in *Nature* [*Lond.*] **169**, 1010 (*June* 14, 1952).

The cross-section of the hydrocarbon chain of several esters and organic acids is calculated from Schytil's equation [Abstr. 6798 (1949)] and found to agree with other estimates. The melting point is defined as the temp. where the translational energy of surface molecules equals the surface free energy. One table is given. R. A. WEAL

532.64 : 541.18

7076. The spreading of liquids on low-energy surfaces. II. Modified tetrafluoroethylene polymers. H. W. FOX AND W. A. ZISMAN. *J. Coll. Sci.*, **7**, 109–2 (*April*, 1952).

For Pt I, see Abstr. 3380 (1951). Data are presented on the equilibrium contact angles of a wide variety of liquids on specially prepared surfaces of halogenated derivatives of polyethylene. The free energy decrease of immersion (f_{SL}), the work of adhesion (W_A) and the spreading coefficients have been calculated for the liquids which do not spread. The free energy decrease on immersion of these solids in the saturated vapour of most of the liquids of this study is shown to be negligible. For each solid surface the contact angle and spreading coefficient follow the relation to liquid surface tension reported previously for polytetrafluoroethylene, i.e. as the liquid surface tension increases, the contact angle increases and the spreading coefficient decreases. Substitution of chlorine or hydrogen for fluorine in these polymers increases W_A, f_{SL}, and the spreading coefficient with respect to a given liquid, the increase depending on the proportion of non-fluorine substituent. Substitution of hydrogen for fluorine has a smaller effect in this respect than substitution of chlorine for fluorine. It is shown that when f_{SL} for a given solid in a series of liquids is constant, the plots of W_A *v.* surface tension and spreading coefficient *v.* surface tension should be straight lines with positive and negative 45° slopes respectively. The data presented for the fluorinated polymers and the liquid *n*-alkanes and di-*n*-alkyl ethers fall on such lines. The values of f_{SL} for the fluorinated polymers plot as a straight line against mole per cent fluorine substitution. There appears to be a maximum value of W_A characteristic of the

olymer, which is identical with the work of adhesion ven by the liquid having a contact angle of 90° on e given solid. It is shown experimentally that there re many exceptions to the "rule" that non-polar quids wet non-polar solids. From the data it is nown that recent attempts to measure the surface nsion of solids by contact angle measurements alone volve unjustifiable assumptions. A.

532.64 : 541.183

077. The spreading of liquids on low-energy surces. IV. Monolayer coatings on platinum. E. G. HAFRIN AND W. A. ZISMAN. *J. Coll. Sci.*, **7**, 166–77 *April*, 1952).

The equilibrium contact angle (θ_E) has been measured for some sixty diverse liquids with respect a smooth platinum surface coated with an adsorbed riented monolayer of *n*-octadecylamine. Linear lations were found between cosine θ_E and the liquid rface tension ($\gamma_{LV}°$) for every homologous series. When homology was disregarded, the cos θ_E *v.* $\gamma_{LV}°$ ata for all the liquids collected on three straight lines, vo of which were approximately parallel. Simple urvilinear relations obtained between the work of dhesion (W_A) and $\gamma_{LV}°$ and between the final preading coefficient ($S_{LV°/SV°}$) and $\gamma_{LV}°$, the conituents of each set of three curves being the same as efore. The grouping on to multiple lines corresponds to differences in the solid/liquid interfacial nsion, γ_{SL}, and to the relative solvent power of the quids for the adsorbed octadecylamine. The same orrelation obtained for the critical surface tension γ_C), which was shown to be specific both to the homoogous series and to the solid surface. Constant alues of the free energy decrease on immersion (f_{SL}) ere observed for the homologous series of *n*-alkanes nd *n*-alkyl ethers, while the alkylbenzene series howed a linear decrease with increasing $\gamma_{LV}°$. From he small range and low experimental values of f_{SL} bserved for many unrelated liquids, it is concluded hat the free surface energy of the monolayer-coated olid is probably not much more than 28·5 erg/cm². he striking similarity observed for the wetting roperties of the monolayer-coated surfaces comared with those reported in Pt III [to be published ater] for surfaces of single crystals of *n*-hexatriaontane and bulk paraffin (5) demonstrates that the vetting behaviour of a surface is essentially controlled y the nature and packing of the outermost group of toms in the molecules. Intercomparison of wetting ata for the monolayer with reference data obtained or a surface of methyl groups in closest packing (i.e. -hexatriacontane single crystals) is proposed as an pproach for determining, from contact angle neasurements, the packing of adsorbed films at the olid/air interface. A.

MOLECULAR THEORY OF LIQUIDS 532.7

532.7

078. On the theory of nearest-neighbour order in iquids. A. E. GLAUBERMAN. Letter in *Zh. Eksper. eor. Fiz.*, **22**, 249–50 (*No.* 2, 1952) *In Russian.*

A density formula is derived which takes account f heat-vibrations of the atoms of the liquid; the density thus depends on temperature T directly and through the coeff. of structure diffusion D, whose dependence on T is discussed semi-empirically.

J. JACOBS

532.7 : 539.133

7079. X-ray studies of fused salt systems. I. Aluminium (III) chloride. R. L. HARRIS, R. E. WOOD AND H. L. RITTER. *J. Amer. Chem. Soc.*, **73**, 3151–5 (*July*, 1951).

532.7 : 539.133

7080. X-ray studies of fused salt systems. II. Indium(III) iodide. R. E. WOOD and H. L. RITTER. *J. Amer. Chem. Soc.*, **74**, 1760–2 (*April* 5, 1952).

An analysis of the X-ray diffraction pattern indicates tetrahedral co-ordination of I atoms around In atoms rather than trigonal or octahedral co-ordination. The length of the In–I bond is 2·70 Å. It is not possible to establish definitely from the radial distribution curve whether liquid indium iodide is predominantly monomeric or dimeric. It seems probable that both species are present. A geometrical configuration for the dimer which is consistent with the radial distribution curve is proposed. A.

532.7 : 539.133

7081. X-ray studies of fused salt systems. III. Tin(IV) iodide. R. E. WOOD AND H. L. RITTER. *J. Amer. Chem. Soc.*, **74**, 1763–4 (*April* 5, 1952).

The liquid appears to consist of independent tetrahedral molecules of SnI_4 with an Sn–I distance of 2·66 Å and an I–I distance of 4·35 Å. There is no order beyond the short range order of single molecules. A.

532.7 : 539.27 : 536.7

Mixtures (The theory of the equilibrium properties of some simple classes of mixtures, solutions and alloys). *See Abstr.* 7245

532.7 : 541.64

7082. A note on the theory of the high polymer solution. H. ICHIMURA. *J. Phys. Soc. Japan*, **7**, 182–5 (*March–April*, 1952).

The free energy of mixing dilute high polymer solution is calculated by a new approximational method which may clarify how the interaction between the solvent and the solute molecules should be taken into account. It is based on the idea somewhat analogous to the cage model theory of the liquid state and may be considered to unite the quasi-lattice model theory and the gas-like model theory. But it does not use the idea of the potential of the average force as in Zimm's theory. The osmotic pressure formula is derived and it is shown that the second osmotic coefficient depends explicitly on the solvent-segment interaction through a complicated function even in the simplest case where the solute molecule may be expressed with the rigid sphere with the well-type attraction potential. A.

532.712

7083. Osmotic pressure in gravitational field. H. LANG. Note in *Z. Naturforsch.*, **7a**, 299–300 (*March–April*, 1952) *In German.*

The osmotic pressure varies with height within the solution, and is always related to its parameters of state (concentration and pressure) occurring in the sedimentation equilibrium at the given height.

F. LACHMAN

532.72 : 535.324.2

7084. A study of the diffusion of urea in water at 25° with the Gouy interference method. L. J. Gosting and D. F. Akeley. *J. Amer. Chem. Soc.*, **74**, 2058–60 (*April* 20, 1952).

The variation with concentration of the diffusion coefficient, D, of urea in water has been measured in the concentration range from 0 to 4 molar. These values of D are self-consistent to within about 0·1%, and it was established that the results obtained are differential diffusion coefficients. As the Gouy interferometer measures the optical path difference between the two solutions forming each diffusion boundary, refractive index data for the system were also obtained. A.

532.72 : 537.363

7085. Solution of boundary spreading equations for electrophoresis and the velocity ultracentrifuge. L. J. Gosting. *J. Amer. Chem. Soc.*, **74**, 1548–54 (*March* 20, 1952).

By direct solution of the boundary spreading equations for ideal electrophoresis or velocity ultracentrifuge experiments, respectively, expressions are obtained relating the experimentally measured refractive index gradient curves to the mobility or sedimentation constant distributions in the sample. Discussion of the distribution functions and derivation of the boundary spreading equations are included, together with the conditions which must be satisfied for the spreading to be ideal. It is shown that the correct distribution of mobilities or sedimentation constants may be obtained by an appropriate extrapolation method regardless of whether all molecules have the same diffusion constant.

532.782

7086. Kinetics of crystalline nucleus formation in supercooled liquid tin. G. M. Pound and V. K. La Mer. *J. Amer. Chem. Soc.*, **74**, 2323–32 (*May* 5, 1952).

Oxide coated droplets of molten tin of a narrow size range were supercooled to 120° below their melting point of 232°. The droplets were of the order of magnitude of 5 microns in diameter, and the specimens, which were studied by means of a dilatometric technique, each consisted of several grams or about 10^{10} of these droplets. The solidification rate increases rapidly with decrease in temperature and increase in droplet size. The nucleation process appears to be inhomogeneous, i.e. assisted by small particles of foreign solids randomly distributed among the droplets, because of the marked decrease in reaction rate from the beginning to the end of a rate measurement. Application of Poisson's distribution function to the data shows that the nucleating impurities are present in the droplets in amounts proportional to droplet area rather than volume. Two different theoretical equations for heterogeneous nucleation rate fit the data. The following have been computed from the data: (*a*) minimum solid-liquid interfacial free energy for tin is $58·5 \pm 1$ erg/cm^2 at 115°; (*b*) kinetic coefficient for heterogeneous nucleation is 3×10^{34} cm.$^{-3}$ sec.$^{-1}$ to within a power of 10. Assuming a frequency factor RT/Nh, the theoretical kinetic coefficient for homogeneous nucleation is 3×10^{35} cm.$^{-3}$ sec.$^{-1}$. This agreement is thought to be fortuitous, and indicates that the kinetic coefficien is not a reliable criterion of homogeneous nucleatio

MECHANICS OF GASES 533

533.16 : 541.1

7087. Measurements of the physical properties o active nitrogen. J. M. Benson. *J. Appl. Phys.*, 23 757–62 (*July*, 1952).

Measurements were made of the heat release during decay of the afterglow, the viscosity, and th free electron density in active N. Calorimete measurements of the heat released during decay o the afterglow amounted to as much as 22·3 calorie per gram of the gas, corresponding to an excitatio of one part in 350 of the molecules present to an energ of 9·6 eV. The viscosity of the active N was foun to be the same as that of the unactivated N withi ½ of 1%. Ionization in a stream of active N is show to be incidental rather than essential to the productio of the Lewis–Rayleigh afterglow. Microwav measurements of the free electron density in a strea of active N indicated one free electron for eac $2·3\times10^8$ molecules in the stream. Contrary t Mitra's theory, probes in the stream were found t respond to carriers of negative sign rather tha positive ions. Space discharges in an expandin stream of active N are attributed to free electron moving with the stream. In the use of active N fo studies of low density flow, by observation of th afterglow, disturbing effects will occur because o heating and ionization, but the disturbances appea not to be so large as to interfere with its use. A

533.1

7088. A simple automatic gas flow-limiting valv F. Call. *J. Sci. Instrum.*, **29**, 246–7 (*Aug.*, 1952).

The valve limits the flow rate of gases to a maximu value irrespective of the suction applied. It is capabl of maintaining the flow rate constant over a wid range of driving pressures. Adjustments are provide for varying this constant flow rate between wid limits. A

533.27

7089. Pressure-humidity apparatus. A. Wexle and R. D. Daniels, Jr. *J. Res. Nat. Bur. Stand* [*Wash.*] **48**, 269–74 (*April*, 1952).

An apparatus for producing atmospheres of know relative humidity, based on the "two-pressur principle," is described. It has a working space (te chamber) of 1 ft^3, in which the relative humidity ma be varied and controlled from 10 to 98%, the tem perature from −40° to +40°c, the air flow up t 150 l/min, and the test-chamber pressure from ½ t 2 atmospheres. The humidity in the test chambe may be set and maintained to an accuracy of at leas ½% relative humidity. A

533.

7090. Absorption of carbon mono-oxide by th barium getter. I. Experiments at low temperature T. Arizumi and S. Kotani. *J. Phys. Soc. Japan*, 7 152–8 (*March–April*, 1952).

The absorption properties of flashed Ba gette below 0°c were studied in c.f. and c.v. methods. Th

getter absorbed a comparatively large amount of CO given at −185°C, not so much differing from that at −78°C, indicating that the absorption is not a simple physical adsorption. The pressure changes in the c.v. method are represented by $dp/dt = -\alpha p(a - bp)$ and $dp/dt = -\beta p$ respectively for lower and higher temperature ranges. Raising the temperature of the getter mirror stepwise, from −180°C, the absorbed gas was desorbed at first, but it began to be absorbed again by the getter. For comparison, the absorption properties of the Cu–CO system was also studied. A.

533.5

7091. Absorption of carbon mono-oxide by the barium getter. II. Theory of physical adsorption. T. ARIZUMI AND S. KOTANI. *J. Phys. Soc. Japan*, **7**, 58–63 (*March–April*, 1952).

The simple theory of physical adsorption was found to hold only for the getter having already absorbed a sufficient amount of CO. The large absorption ability of a fresh getter is due to the existence of large number of lattice imperfections in it. The activation energy of physical adsorption, desorption and activated adsorption for Ba–CO system were found 1·0, 1·4 and 6·5 cal/gmol respectively. The new theory assuming the existence of lattice imperfections was developed. A.

533.5

7092. Absorption of carbon mono-oxide by the barium getter. III. Lattice imperfections. T. ARIZUMI AND S. KOTANI. *J. Phys. Soc. Japan*, **7**, 163–6 (*March–April*, 1952).

The analysis in Pt II showed that only a small portion of whole gettering process of Ba was explained by simple adsorption theory. However, the phenomena may be thoroughly clarified assuming that the getter mirror contains a large number of lattice imperfections, whose evidences are found in many experimental results. A new theory will be presented which agrees qualitatively with the obtained results. A.

533.5

7093. Absorption of carbon mono-oxide by the barium getter. IV. Absorption experiments in the temperature range between 0°C and 250°C. T. ARIZUMI AND S. KOTANI. *J. Phys. Soc. Japan*, **7**, 415–21 (*July–Aug.*, 1952).

At low temperatures, CO was apparently absorbed by the getter, while its resistance remained almost unvaried. At higher temperature than about 150°C, however, the resistance changed remarkably as the getter absorbed the gas. The ionization of the introduced gas made the absorption of the getter rather vigorous. In the c.f. method the pressure decreased at first to a minimum value and then it began to increase, suggesting that another kind of gas was formed by the catalytic action on the getter surface. The phenomena were studied in details. The alternative introduction of CO and O gave a clue to the absorption state of CO. A.

533.5

7094. Absorption of carbon mono-oxide by the barium getter. V. Theory of absorption. T. ARIZUMI AND S. KOTANI. *J. Phys. Soc. Japan*, **7**, 422–6 (*July–Aug.*, 1952).

The theory presented in Pt II was also applicable to the gettering process at room temperature. The activation energies for the activated adsorption of CO and for the desorption of CO_2, having been formed by the catalytic action, were estimated to be 7·5 and 8·8 kcal/g mol respectively. At higher temperatures than 150°C, some kind of compound was formed and the conductivity of the getter mirror changed remarkably. In addition, the probable state of activated adsorption of CO on the getter surface will be postulated. A.

533.5

7095. Gettering process of barium—sorption properties of oxygen to barium. T. ARIZUMI AND S. KOTANI. *J. Phys. Soc. Japan*, **7**, 300–7 (*May–June*, 1952).

O is mainly adsorbed physically on to the active centres, below −150°C, differing from other kinds of gas. The activation energy for the physical adsorption is 0·3 ∼ 0·9 kcal/g mol. At temperatures between −150°C and −30°C, it is adsorbed in the activated state and its activation energy is 5·8 kcal/g mol. Beyond −30°C O combines with Ba to form oxide. A.

533.5

7096. Modification of steam valves for high vacuum use. P. F. YERGIN. Note in *Rev. Sci. Instrum.*, **23**, 310 (*June*, 1952).

Slight modifications to bronze gate valves of the nonrising stem, solid wedge type, to take O-rings and to improve the vacuum tightness are described and illustrated. S. WEINTROUB

533.5

7097. A high vacuum flow analogy. G. W. MONK. Letter in *J. Appl. Phys.*, **23**, 799–800 (*July*, 1952).

The Knudsen equation for the mass of flow of gas through a cylindrical tube of radius R and length L under high vacuum conditions can be written as $N = 4\pi R^3(\nu_1 - \nu_2)/3L$, where N is the net number of molecules flowing down the tube per second, and ν_1, ν_2 the numbers of molecules striking unit area per second at the ends of the tube. Analogously this should also hold for the flow of photons down a tube with rough and highly reflecting inner surface, giving $P = 8\pi R^3(I_1 - I_2)/3L$ for the power where I_1 and I_2 are the intensities at distance L apart. Thus information concerning pumping speeds of complicated vacuum systems could be determined from measurements of electromagnetic conductance of simulated system. S. WEINTROUB

533.5

7098. A new low impedance high vacuum valve. J. S. WAHL, S. G. FORBES, W. E. NYER AND R. N. LITTLE. Letter in *Rev. Sci. Instrum.*, **23**, 379 (*July*, 1952).

Construction, materials, dimensions and performance of vacuum valves in which a flat vane slides across an O-ring are described. No leak could be detected with an ionization gauge, but small through-leaks were shown with a helium leak detector. G. WITTENBERG

533.5

7099. The high temperature Pirani gauge. J. H. LECK. *J. Sci. Instrum.*, **29**, 258–63 (*Aug.*, 1952).

The operating conditions required for a Pirani gauge to operate in the pressure range 0–5 mm of

mercury have been investigated. A comparison between tungsten and platinum wire for use as the gauge element has shown that both have disadvantages when operated above 450°K. A.

533.6.011

7100. The discharge of compressed gas from pipes. E. M. Tseĭrov. *Zh. Tekh. Fiz.*, **21**, 842–52 (*No.* 7, 1951) *In Russian.*

Sudden discharge of a compressed gas from a pipe is a non-stationary phenomenon which proceeds more slowly than the stationary discharge and consists of three phases: (1) the discharge is accompanied by a rarefaction wave moving at sound velocity towards the closed end of the tube; the critical pressure ratio is 0·279 (as compared with 0·527 in the stationary discharge); (2) a reflected wave moves at the velocity of sound plus the velocity of gas flow towards the mouth of the tube, where the parameters of flow remain unchanged; (3) pressure falls by the same amount along the whole tube; gas velocity at the closed end equals zero and at the mouth the critical value. Tests on a 5·25 m long, 44 mm dia. tube containing air at 16 atm, and a 5·75 m long, 44 mm dia tube with air at 13·4 atm confirm the derived equations. A. GELBTUCH

533.6.011

7101. On the uniqueness of gas flows. J. L. Ericksen. *J. Math. Phys.*, **31**, 63–8 (*April*, 1952).

The conditions requisite that two plane, stationary, irrotational, insentropic gas flows shall have the same streamline patterns are studied mathematically, the notation of Cartesian tensors being used. It is shown that, in general, the velocity fields of the two flows must be strictly proportional and the adiabatic exponents of the two flows must be identical. Exceptions to this may occur, only if the flows are of vortex type, the streamlines being either parallel straight lines or concentric circles, or if the flows are of source-sink type. J. S. G. THOMAS

533.6.011

7102. The transients arising from the addition of heat to a gas flow. P. M. Stocker. *Proc. Camb. Phil. Soc.*, **48**, 482–98 (*Pt* 3, 1952).

Problems involving the addition of heat to a flowing gas have received considerable attention in recent years, mainly owing to their application to ram jets and similar engines. The most surprising result is: if heat is supplied to a fluid flowing, with subsonic velocity, through a pipe, then the temperature of the fluid rises if the Mach number $< \gamma^{-1/2}$, but falls if it is $> \gamma^{-1/2}$. The explanation of this result lies in the transients involved and their effects on the boundary conditions at the ends of the heating region, and mistakes of interpretation have arisen owing to confusion between space- and time-derivatives. A full and clear explanation necessitates study of the whole transient motion in the flow. The present work deals with the flow in a pipe, infinite in both directions with uniform heat addition over a certain length. The case of a finite pipe into which air is fed from a large reservoir, and which is discharged at constant pressure, is treated; the transient solution is found, and the manner in which it tends to the final steady-state soln. is discussed. A "modified linear" theory is developed to deal with the difficulty met when the Mach number of the flow is $\simeq 1$. Solutions obtained by linear and "modified linear" theories are compared graphically. The "modified linear" theory takes account of the most important non-linear effects, and is satisfactory for discussing unsteady flow problems in which heating occurs at a Mach number not far from 1; when the Mach number is not close to 1, the increased accuracy obtained by application of the "modified linear" theory is a worthwhile improvement on the ordinary linear theory. J. S. G. THOMAS

533.6.011 : 534.21

7103. Streaming at hot solid bodies in a stationary sound wave. P. N. Kubanskiĭ. *Dokl. Akad. Nauk SSSR*, **82**, 585–8 (*No.* 4, 1952) *In Russian.*

The production of currents of air at the surface of a heated tube situated along the axis of a system of stationary waves of a frequency of 8–30 kc/s has been investigated by a photographic method. The sound intensity was measured with a radiometer and the wavelength with a Kundt's tube. Unless the frequency of the starting wave system is a natural frequency of the tube, the photograph only shows natural convection, but for resonance a series of jets are obtained. As there are several jets to each half-wavelength it is concluded that the effect is due to harmonics, i.e. non-linear vibrations. J. M. HOUGH

533.6.011.31

7104. Application of the thin-wing-expansion method to the compressible flow past an elliptic cylinder. H. Hasimoto. *J. Phys. Soc. Japan*, **7**, 322–8 (*May–June*, 1952).

Imai's thin-wing-expansion method is applied to a uniform flow past an elliptic cylinder at zero angle of attack, in order to obtain the analytic expressions correct to the third approximation for the complex velocity potential, and for the velocity distribution over the cylinder. Numerical calculation is made for the case $t = 0{\cdot}1$ where t is the thickness ratio of the cylinder. The convergence of the result seems to be satisfactory except near the stagnation point, where the anomalous behaviour appears. A.

533.6.011.4

7105. Experiments on separation of boundary layers on probes in front of blunt-nosed bodies in a supersonic air stream. W. A. Mair. *Phil. Mag.*, **43**, 695–716 (*July*, 1952).

If a blunt-nosed body of revolution is fitted with a slender probe at the nose and placed in a supersonic air stream, there is an interaction between the shock wave in front of the body and the boundary layer on the probe. Schlieren photographs of this type of flow were taken for bodies of revolution with hemispherical and flat noses and various lengths of probe, at a Mach number of 1·96. Measurements of pressure distribution were also made on the hemispherical-nosed body for one length of probe. With the flat-nosed body there is a regular oscillation between widely different types of flow. A detailed discussion of the relations between different phases of the oscillation is given. This throws some light on the general problem of the interaction of shock waves and boundary layers. Schlieren photographs were also taken of the corresponding two-dimensional flow, using a thin plate clamped between two thicker flat-nosed plates.

he flows for various protruding lengths of the thin ate were in general similar to those found with the odies of revolution, except that the unsteady flows und for a range of plate lengths did not have the gular oscillatory form found with the flat-nosed ody of revolution. A.

533.6.011.5

106. The use of a coronamicrophone in the shock ube. D. WEIMER. Note in *Rev. Sci. Instrum.*, **23**, 77–8 (*July*, 1952).

The use of seven corona point discharge tubes, rranged in parallel, close together, in aerodynamic udies is briefly described. The gauge is calibrated atically in a small chamber by varying the p.d. etween the electrodes and measuring the current ow as a function of the air pressure in the chamber. Use of a shock tube allows the gauge to be subjected o instantaneous changes of pressure, temperature nd density, by passage of the shock wave, the gauge eing suitably mounted 9 in from the end plate of the hock tube, so that incident and normally-reflected hock waves pass over the gauge and are recorded by cathode ray oscillograph. The device is a valuable ool for the measurement of transient pressure hanges. J. S. G. THOMAS

533.6.011.5 : 534.222.2

107. On the shock wave in the elastic medium. Z. KUSUKAWA. *J. Phys. Soc. Japan*, **7**, 200–3 (*March–April*, 1952).

As the result of the four conservation laws, i.e. hose of the conservation of mass, momentum, energy nd the area of the section of the tube of flow, the ollowing conclusions for the shock wave induced in he elastic medium have been obtained. 1. When the wedge moved with the supersonic speed z, the angle be- ween the shock wave and the direction of undisturbed velocity denoted by α is $\alpha = \sin^{-1}(M^{-1}) + \theta$, where $\theta = [(3\lambda + 2\mu)/(\lambda + 2\mu)][(M^4\alpha^2\beta\delta^2)/(4C_0(M^2-1)^{2/3})]$, nd $M = z/a$. a, β, c_0, λ and μ, and δ denote the peed of sound, the coefficient of the linear expansion, he specific heat, Lamé's constants of the elastic nedium, and the half vertex angle of the wedge resp. 2. The plane shock wave is reflected by the plane igid wall, α and α' denoting the angles included between the incident or reflected waves and the wall, $\tan\alpha' = \{\eta x(1 + \eta^2x^2) - x(1 - \eta^2)[1 + \eta^2x^2(\eta^2 - 1)]^{1/2}\}/\{(1 + \eta^2x^2)[1 + \eta^2x^2(\eta^2 - 1)]^{1/2} + \eta x^2(1 - \eta^2)\}$, where $x = \tan\alpha$, $x' = \tan\alpha'$, and $(1 - \eta^2)$ represents he strength of shock. A.

533.6.013.22

7108. Experimental study of the spectrum of isotropic turbulence. II. H. SATO. *J. Phys. Soc. Japan*, **7**, 392–6 (*July–Aug.*, 1952).

For Pt. I see Abstr. 3370 (1952). In the isotropic urbulent field, energy spectrum was observed by an mproved equipment. The measurements were made n a closed channel which was added to the exit cone of an open-type wind-tunnel. A voltage integrator was used to read the fluctuating output of l.f. components. Low-cut filter attached to the input terminal increased the accuracy at h.f. region. Measured spectrum curves are nearly the same as previously reported. The decay of spectral components is severer at high wave-number throughout decay process. The energy transition is estimated from the measurements above mentioned. The wave-number of zero transition decreases as the turbulence decays. Finally, the gradient of spectrum curve is determined by differentiating the spectrum with respect to wind-speed. At medium wave-number region the power index is about $-5/3$. Three-dimensional spectrum is also obtained by this method. A.

533.6.013.22 : 534.232

7109. The generation of noise by isotropic turbulence. I. PROUDMAN. *Proc. Roy. Soc. A*, **214**, 119–32 (*Aug.* 7, 1952).

A finite region, with fixed boundaries, of an infinite expanse of compressible fluid is in turbulent motion. This motion generates noise and radiates it into the surrounding fluid. The acoustic properties of the system are studied in the special case in which the turbulent region consists of decaying isotropic turbulence. It is assumed that the Reynolds number of the turbulence is large, and that the Mach number is small. The noise appears to be generated mainly by those eddies of the turbulence whose contribution to the rate of dissipation of kinetic energy by viscosity is negligible. It is shown that the intensity of sound at large distances from the turbulence is the same as that due to a volume distribution of simple acoustic sources occupying the turbulent region. In this analogy, the whole fluid is to be regarded as a stationary and uniform acoustic medium. The local value of the acoustic power output P per mass of turbulent fluid is given approximately by the formula $P = -\frac{3}{2}\alpha\overline{d\vec{u}^2}/dt(\overline{\vec{u}^2}/c^2)^{5/2}$, where α is a numerical constant, $\overline{\vec{u}^2}$ is the mean-square velocity fluctuation, t is the time, and c is the velocity of sound in the fluid. The constant α is expressed in terms of the well-known velocity correlation function $f(r)$ by assuming the joint probability distribution of the turbulent velocities and their first two time-derivatives at two points in space to be Gaussian. The numerical value $\alpha \sim 38$ is then obtained by substituting the form of $f(r)$ corresponding to Heisenberg's theoretical spectrum of isotropic turbulence. It is found that the effects of decay make only a small contribution to the value of α, and that the order of magnitude of α is not changed when widely differing forms of the function $f(r)$ are used. A.

MOLECULAR THEORY OF GASES 533.7

533.7 : 537.562

Diffusion and excitation transfer of metastable helium in normal gaseous helium. *See Abstr.* 7360

533.72 : 536.71

7110. On states not in thermal equilibrium. II. N. TAKETA AND T. KOGA. *J. Phys. Soc. Japan*, **7**, 143–5 (*March–April*, 1952).

Miscellaneous notes and correction of previous part [Abstr. 5602 (1950)]. The results are more or less different from those of Enskog and Chapman. At first sight, it seemed that the treatment of Enskog and Chapman might not be correct for lack of interpretation of the physical meanings. But later it was concluded that Enskog–Chapman's solution is correct formally, and further that the variables adopted

by them are of the same physical meanings as those in Koga's treatment. A.

533.72 : 537.534.72

7111. Free molecular flow in the sample inlet to the mass spectrometer. P. D. ZEMANY. *J. Appl. Phys.*, **23**, 1924–7 (*Aug.*, 1952).

The aspects of free molecular flow in the sample inlet to the mass spectrometer are pointed out and the conditions under which such flow can occur are described. Methods for calculating the leak diameter and sample pressure for various flow rates are developed. These principles are illustrated by consideration of the flow characteristics in the mass spectrometer leak detector, and by an example from reaction kinetic studies. The decrease in pressure in the sample reservoir is also described. This is applied to a determination of molecular weights. The effect of the pressure decrease on apparent fragmentation patterns is pointed out and a rational expression for spectrometer sensitivity is suggested which is based on the fraction of molecules which flow through the spectrometer which appear as ions. A.

533.75 : 533.24

7112. Gas theory and the equation of state. XII. Compressibility and liquefaction of argon. J. DUCLAUX. *J. Phys. Radium*, **13**, 199–205 (*April*, 1952) *In French.*

The gas theory, based on progressive association and first applied to nitrogen and oxygen [Abstr. 8564 (1950) and 2456 (1951)], has been extended to argon. Satisfactory agreement with the experimental results is obtained over wide limits. Consideration of the condensation curve, established from the compressibility, allows the *a priori* calculation of the saturation vapour pressure at all temperatures in the absence of measurements made on the liquid.

F. E. HOARE

533.75 : 536.422.15

7113. Interpretation of some measurements of solubility in compressed gases. S. ROBIN AND B. VODAR. *J. Phys. Radium*, **13**, 264–70 (*May*, 1952) *In French.*

A theory of the dissolution of solids or liquids in compressed gases [Abstr. 7623 (1951)] is applied to experimental results obtained by various authors on the composition of the gaseous phase of binary systems. Satisfactory agreement is obtained using values little different from those found in the literature for the force constants of the Lennard–Jones potential. Curves showing the agreement between theory and experiment are given for CH_3OH and H_2O in CH_4, N_2, CO_2 and H_2 at various temperatures, for I_2 in CO_2, C_6H_6 in N_2 and H_2, and CS_2 in CO_2, N_2 and H_2.

F. E. HOARE

VIBRATIONS . ACOUSTICS 534

534.014.5

7114. Some exact solutions in nonlinear oscillations. K. MUNAKATA. *J. Phys. Soc. Japan*, **7**, 383–91 (*July–Aug.*, 1952).

Forced oscillations of systems with nonlinear restoring forces are treated rigorously in certain special cases which are specified by the condition that the harmonic oscillation has a similar wave form to that of the external force. This condition leads to the introduction of the external force represented by the function *cn* for a hard system and by the function *sn* in the case of a soft system, and consequently the solution is given by either of these functions. Response curves obtained are similar to the corresponding response curves which have been given by approximate solutions. To examine the stability of the forced oscillation one must solve Hill's equations, which can be carried out exactly in the present cases. Thus, the stable or unstable regions in the response diagrams are determined definitely and a few questions are clarified. A.

534.134

7115. On a coupled vibration of cylindrical air column with elastic circular discs at both ends. T. TAKAHASI AND N. FUJIMOTO. *Mem. Fac. Sci. Engng Waseda Univ., No.* 15, 15–19 (1951).

Integro-differential equations are derived for the vibrations of thin elastic plates covering the ends of a rigid circular pipe filled with an inviscid compressible fluid. Cases are considered when the two plates vibrate in the same direction, when they vibrate in opposite directions, and when one end plate remains rigid. A. GELBTUCH

534.21

7116. On the propagation of elastic waves in an isotropic homogeneous sphere. Y. NOMURA AND K. TAKAKU. *J. Phys. Soc. Japan*, **7**, 204–11 (*March–April*, 1952).

The results of the calculations are convenient for a further discussion owing to their very clear and simple form, in which the laws of geometrical optics are contained. Various modes of reflection are considered, and the intensity of reflected waves relative to the primary is calculated numerically. A.

534.213.4

7117. An analysis of the effect of the discontinuity in a bifurcated circular guide upon plane longitudinal waves. L. L. BAILIN. *J. Res. Nat. Bur. Stand.* [*Wash.*] **47**, 315–35 (*Oct.*, 1951).

The problem of theoretically accounting for the scattering of sound by a semi-infinite circular tube with a small diameter inserted axially, as a measuring probe, into a larger tube of infinite length, is solved in a rigorous and explicit manner when the incident plane waves are restricted to the lowest propagating mode. The investigation consists in solving Helmholtz's equation subject to boundary conditions on the acoustic velocity potential at rigid walls. With the aid of Green's theorem and the Green's function for a point source in the large guide, an integral representation of the desired velocity potential is obtained. The imposition of the boundary conditions leads directly to a homogeneous integral equation of the Wiener–Hopf type, which is solved by transform techniques. The results of this solution are shown to be related to a distance *d*, which is the length the inner guide must be extended to account for the disturbance occurring in the immediate vicinity of the discontinuity caused by the excitation of higher mode fields. Another satisfactory method of representing the effect of the discontinuity is by the use

of equivalent circuits, by means of which a discontinuity in a wave guide is replaced by a lumped parameter network in a set of transmission lines. The equivalent circuit for this network is derived, and the one essential circuit parameter is related to d and to the explicit solution of the integral equation. Numerical results for d are given as a function of several different guide ratios and driving frequencies of the incident waves. The results are in considerable disagreement with approximation methods previously reported and indicate that these methods are unsatisfactory in the present problem. A.

534.22/.23 : 539.32

7118. Longitudinal and transverse ultrasonic waves in a synthetic rubber. A. W. NOLLE AND P. W. SIECK. *J. Appl. Phys.*, **23**, 888–93 (*Aug.*, 1952).

Velocity and attenuation of both transverse and longitudinal ultrasonic waves are measured in a Buna-*N* vulcanizate at 2, 5, and 10 Mc/s, over a range of temperatures. The method involves use of solid transmission media to conduct pulsed signals into a thin flat specimen. Values of the bulk modulus and of the complex shear modulus are computed from the measurements. It is found that longitudinal-wave losses in this particular synthetic rubber are substantially accounted for by the relaxation phenomena measured in shear, but this conclusion is subject to considerable quantitative uncertainty arising from experimental errors estimated to be as large as 5% for longitudinal-wave acoustic data and 10% for transverse-wave acoustic data. It is found that below approximately −25°c the shear-modulus loss tangent becomes relatively independent of temperature and frequency in the present range. A.

534.22.093.3

7119. The velocity of ultrasonic waves in certain binary mixtures of organic liquids. I. G. MIKHAĬLOV AND A. A. CHISTORAZUM. *Dokl. Akad. Nauk SSSR*, **81**, 779–82 (*No.* 5, 1951) *In Russian.*

The velocity of propagation of ultrasonic waves (frequency 2·869 Mc/s) in mixtures (at 20°c) of (*a*) acetone-CS_2, (*b*) methyl alcohol-CS_2, (*c*) methyl alcohol-benzene, (*d*) acetone-chloroform, (*e*) methyl ethyl ketone-water was measured by an interferometric method. From these measurements the compressibility of the liquid mixtures was calculated. It was found that the velocities of propagation in mixtures (*a*)–(*d*) varies non-linearly with concentration; mixtures (*a*) and (*b*) show a clearly defined minm. velocity at approx. 70% CS_2 and 45% CS_2 respectively, while for (*c*) and (*d*) the velocity is proportional to (concentration)^n where $n > 1$. This form of dependence of propagation velocity upon concentration is attributed to a weakening of the molecular interaction of the separate liquids when they are mixed. Measurements on mixture (*e*) failed to confirm the existence of a sudden change in velocity and compressibility at a concentration of 13% methyl ethyl ketone, previously reported by Tarasov *et al.* (1936). A. SCHOFIELD

534.23 : 534.414

7120. Experimental investigation of resonator sound absorbers. K. A. VELIZHANINA. *Zh. Tekh. Fiz.*, **21**, 1087–99 (*No.* 9, 1951) *In Russian.*

Tests show that if the frequency of natural oscillations of the front wall of the resonator f_w is close to that for the resonator cavity f_c, the curve of the sound absorption coefficient v. frequency shows a marked dip, which can be reduced by increasing the damping of the front wall. If, however, $f_w \gg f_c$, the wall can be regarded as ideally rigid. No porous substance was used in the mouths of the resonators investigated, friction in the mouth being the only cause of energy dissipation. The effect of heat conductivity of the walls on the dissipation has been studied. All results confirm the theoretical considerations of S. N. Rzhevkin and Ter Osipov [*ibid.*, **11**, No. 1–2 (1941); **16**, No. 4 (1946)]. A. GELBTUCH

534.23

7121. The absorption of ultrasonics in dilute solutions of phenol in carbon tetrachloride. W. MAIER AND A. MEZ. Note in *Z. Naturforsch.*, **7a**, 300–1 (*March–April*, 1952) *In German.*

534.23

7122. Sound absorption in vibrating transformer oil. F. SEIDL AND H. FELLNER-FELDEGG. *Acta Phys. Austriaca*, **5**, 504–9 (*No.* 4, 1952) *In German.*

An investigation of the changes produced in pure transformer oil by the passage of sound waves. Observations of viscosity, density and the velocity and absorption of sound waves are made. T. C. TOYE

534.231

7123. On a variant of the Töpler method applied to observation of ultrasonic fields. M. A. ISAKOVICH AND M. G. SIROTYUK. *Zh. Tekh. Fiz.*, **21**, 715–16 (*No.* 6, 1951) *In Russian.*

The method discussed makes use of thermal changes in a transparent solid medium when traversed by ultrasonic waves. W. W. GEHR

534.232

7124. The acoustical field near a circular transducer. E. W. GUPTILL AND A. D. MACDONALD. *Canad. J. Phys.*, **30**, 119–22 (*March*, 1952).

An approximate solution for the near field of a circular transducer is given. The results indicate that, if a similar transducer is used as a receiver, the measured particle velocity is equal to $1 + (2 \cdot 70/(ka)^2)$ times the plane wave velocity, where ka is the number of wavelengths in the perimeter of the transducer. A.

534.232

7125. Remarks on a paper entitled "Calculation of the directivity index of various types of radiators." H. STENZEL. Letter in *J. Acoust. Soc. Amer.*, **24**, 417–18 (*July*, 1952).

Criticisms are made of the paper by Molloy [Abstr. 3184 (1948)]. Some errors are pointed out, and a different approximation in the solution of the directivity index calculation is claimed to give more accurate results. G. F. HODSMAN

534.232 : 533.6.013.22

The generation of noise by isotropic turbulence. *See Abstr.* 7109

534.321.9

7126. Ultrasonics and their application. S. YA. SOKOLOV. *Zh. Tekh. Fiz.*, **21**, 927–36 (*No.* 8, 1951) *In Russian.*

A review devoted mainly to the work on ultrasonics by the present author and published previously

(12 refs). This includes work on: (*a*) the anisotropic character of the distribution of ultrasonic waves in piezoelectric quartz leading to the development of an ultrasonic defectoscope for detecting defects in metals; (*b*) the principles and construction of an ultrasonic microscope; (*c*) the study of physico-chemical processes using ultrasonics, such as the rates of reaction, measurement of the conc. of one medium in another, measurement of small temperature variations in a medium and the development of diffusion.

W. HUGHES

534.39

7127. Experiments with sound vibrations of high intensity. F. L. HOPWOOD. *Sci. Progr.*, **40**, 233–44 (*April*, 1952).

Describes various powerful forms of gas-flame-operated singing tubes which are readily coupled to other systems as a driver. Heat is supplied by a special gas burner to the lower end of a steel tube 30 in long and 3 in dia. fitted with a side tube 15 in long and 3 in dia. This side tube constitutes a very powerful source which is used to drive a Kundt's tube at large amplitude, various diaphragms and compound pendulums, sonic water fountains and pumps, jets in air-liquid coupled systems, and rows of pulsating air bubbles in a liquid-filled tube. The paper concludes with a discussion of such phenomena with interesting deductions relative to the general behaviour of bubbles pulsating in limited masses of water, and to the large fluctuating bubbles associated with submarine explosions. A. B. WOOD

534.61

7128. Sonde method of measuring the ultrasonic field intensity. S. MORITA. *J. Phys. Soc. Japan*, **7**, 214–19 (*March–April*, 1952).

A new probe method of measuring the field intensity of ultrasonics was devised. The probe is made of a small ball (about 2 mm in diameter) of sound-absorbing material, in which a thermistor of much smaller dimensions is included in its centre. From experimental results and theoretical considerations, two noteworthy facts are derived. They are "surface heat generation" (on the surface of any solid material heat is generated in an ultrasonic field) and the cooling effect of ultrasonic waves. A.

534.7 : 612.85

Physiological acoustics. Hearing. *See Abstr.* 7780–1

534.76 : 612.858.751 : 621.395.61

7129. The stereophonic reproduction of speech and music. J. MOIR AND J. A. LESLIE. *J. Brit. Instn Radio Engrs*, **12**, 360–6 (*June*, 1952).

Methods of achieving true and pseudo stereophony are described. Factors responsible for the stereophonic effect are discussed, and it is shown that the loudness difference at the two ears makes no significant contribution to the accuracy of location. A.

534.861.029.4 : 621.395.625 : 621.317.79

7130. Measurement of pitch fluctuations. H. VOLLMER. *Funk u. Ton*, **6**, 169–75 (*April*, 1952) *In German.*

The various causes of fluctuations of pitch in sound reproduction apparatus are discussed and a description, with outline circuit diagram, is given of an instrument for measuring such fluctuations. A phase bridge is used in conjunction with a standard test frequency of 5 kc/s. The percentage frequency deviation can be read directly from the scale of the indicating meter, which has two scales with ranges of $\pm 0{\cdot}5\%$ and $\pm 1{\cdot}5\%$ respectively. An input voltage of about 80 mV is required. The output of the phase measurement bridge can be fed to a c.r.o. for recording. The dependence of the deviation readings on the modulation frequency is measured by means of a "wobbulator." The method used for measurement of slip in the case of magnetic-tape reproducers is outlined. A. WILKINSON

534.862.3/.4 : 621.395.625

7131. Intensity-modulated line recording of sound and its reproduction. P. G. TAGER. *Zh. Tekh. Fiz.*, **21**, 753–6 (*No.* 7, 1951) *In Russian.*

The sound-modulated c.r.t. beam current, by means of a saw-tooth sweep, produces a line on the c.r.t. screen which is photographed on a film moving at right-angles to the sweep. Mathematical analysis shows that for straight-line sweep, the record should be free from non-linear distortion, which, however, would be introduced in playing back, to an extent depending on (*a*) the size of the c.r.t. spot in the direction of the trace; (*b*) the width of the record line; (*c*) the aperture of the optical slit of the reproducing device. Theoretically, the closeness of the lines, even to partial superposition, should not affect reproduction. Optimum line widths and saw-tooth sweep frequencies are derived. F. QUELON

OPTICS . RADIATION . SPECTRA 535

535.214.6

7132. Negative photophoresis and its relation to a recent radiometric experiment. P. TAUZIN. *C.R. Acad. Sci.* [*Paris*] **234**, 2265–7 (*June* 4, 1952) *In French.*

It is shown that the attraction by light of one vane of a radiometer which carries a deposit of smoke is not a true photophoresis effect, and that the temperature difference between the two faces cannot be accurately measured. See Abstr. 6335 (1950).

N. CORCORAN

535.214.6

7133. Further research on particles which move in circular orbits under the influence of light at pressures in the region of 10 torr. E. SCHEU AND K. V. DESOYER. *Acta Phys. Austriaca*, **5**, 435–9 (*No.* 4, 1952) *In German.*

A continuation of Ehrenhaft's work. Experiments carried out on graphite powder in air and argon at pressures between 2 and 20 mm Hg in horizontal sunlight, carbon arc light or metal filament light, showed that the particles moved in helical orbits, some keeping an almost constant velocity for 24 hours. The motion was in all cases consistent with positive photophoresis. N. CORCORAN

535.24

7134. Photometry at very low brilliance levels. A. M. KRUITHOF AND W. DE GROOT. *Comm. Int. Eclair.* [*CIE*] 12*th Mtg*, 1951. *Volume* 2, *Paper D*, 9 *pp.* (1952).

Describes the results of comparing two lights *a*) with the colour difference 7700° to 2042°K, and *b*) at colour match, using an annular form of field with an overall diam. of 8°. The lights reaching the central area and the annulus could be rapidly interchanged. Observations were made by 4 subjects (one deuteranomolous) with both foveal and 4° parafoveal division and at luminance levels from about 1 to 0·003 cd/m². The individual results are shown graphically. J. W. T. WALSH

535.241.3

7135. Results of the comparison of national standards of luminous intensity and flux carried out at the Bureau International des Poids et Mesures. J. TERRIEN AND H. MOREAU. *C.R. Acad. Sci.* [*Paris*] **234**, 2267–9 (*June* 4, 1952) *In French.*

Comparisons have been made of lamps measured at the national laboratories of Germany, U.S.A., France, Great Britain, Japan and U.S.S.R. These lamps give the values of the candela at colour temperatures of 2042° and 2353°K, and of the lumen at 2353° and 2788°K as realized at these laboratories. The methods of comparison are described and the results are tabulated. The differences between the individual values and the mean is generally less than 0·5%. J. W. T. WALSH

535.241.3

7136. Remarks on the preceding paper. A. DANJON. *C.R. Acad. Sci.* [*Paris*] **234**, 2269–70 (*June* 4, 1952) *In French.*

The comparisons described in the previous paper are the first to be made since the new unit, based on the primary standard, was introduced on 1st Jan., 1948. The photometric laboratory at the B.I.P.M. secures agreement between the values of the units used at the national laboratories and can standardize lamps for countries which do not possess a primary standard. J. W. T. WALSH

535.241.44 : 628.9

7137. Subjective appraisal of brightness. S. K. GUTH. *Comm. Int. Eclair.* [*CIE*] 12*th Mtg*, 1951, *Volume* 2, *Paper E*, 22 *pp.* (1952).

Describes an investigation designed to obtain the subjective appraisal of different sources by an observer who is performing a critical visual task. The criterion used was the "borderline between comfort and discomfort" and the experimental arrangement was the same as that adopted for previous work on glare sources. See Abstr. 877 B (1950); *Illum. Engng* [*N.Y.*] **44**, 650–70 (*Nov.*, 1949). J. W. T. WALSH (R)

535.247

7138. A method for spectral calibration of photomultipliers at low intensity levels. E. H. GILMORE AND R. H. KNIPE. *J. Opt. Soc. Amer.*, **42**, 481–3 (*July*, 1952).

A MgO surface is used as an attenuator for the direct calibration of photomultiplier tubes at low intensity levels. The photomultiplier response is compared with that of a thermopile by irradiating the photocathode with a constant fraction of the total radiation striking the thermopile receiver. The beam incident upon the thermopile receiver is attenuated on the order of 1 : 20 000 with the MgO surface, allowing one to calibrate at anode currents of about 2 μA or less. Results are given for three tubes for the 2536–3663 Å region. The standard deviation from the mean averages 5%. A.

535.247.4

7139. Electrophotometer with vacuum cell and a.c. amplification. H. HINTEREGGER. *Acta Phys. Austriaca*, **5**, 496–503 (*No.* 4, 1952) *In German.*

A photoemissive vacuum cell is used as an a.c. amplifying element the factor of which is controlled by illumination. The principle is explained by the fact that the tangent of the curves relating photocurrent to the voltage becomes proportional to illumination, if the cell is run at a certain point of space-charge region. A.

535.31

7140. Calculation of the distribution of light in the image of a line. W. H. STEEL. *Rev. Opt.* (*Théor. Instrum.*) **31**, 334–40 (*July*, 1952) *In French.*

The distribution of light in the image of an incoherent line source is considered in the two principle directions: in the plane of the image and along the axis. In both cases the direct calculation is compared with that using the Fourier transform. A.

535.316

7141. A new thin lens form. S. ROSIN. *J. Opt. Soc. Amer.*, **42**, 451–4 (*July*, 1952).

A general qualitative analysis of the aberrations of a thin lens system is given and applied to a triplet lens form which is quite flexible in adjustment of those aberrations which are capable of being varied in thin lens systems, particularly with regard to the axial secondaries, zonal spherical aberration, and spherochromatism. In its highly corrected state the lens form, of which three general examples are given, may be made to fulfill the conditions of Fraunhofer and Gauss at high relative apertures with mild curves and insensitive spacing. A.

535.317

7142. The contributions of the single surfaces to the diapoint coordinates. M. HERZBERGER. *J. Opt. Soc. Amer.*, **42**, 544–6 (*Aug.*, 1952).

The simple formula suggested below contains, as a special case, the so-called Petzval formula, which gives the field curvature of an optical system in a form which contains a general invariant of the optical system and which is expressed by the powers alone, independent of the centre distances. Let x, y, z, be the coordinates of the object point, and the coordinate of a diapoint where the origins are assumed at the centres of the first and last surfaces, and where the z axis has the direction of the axis of symmetry. If ξ_ν, η_ν, ζ_ν are the direction cosines of the ray in the νth medium multiplied by η_ν, equations can be derived of the form $1/x'\xi' = 1/x\xi + \Sigma(\phi_\nu/\xi_\nu\xi_\nu)$, $1/\gamma'\eta' = 1/\gamma\eta + \Sigma(\phi_\nu/\eta_\nu\eta_\nu)$, whereas $1/z'\zeta'$ is given as a continued fraction containing $\phi_\nu/\zeta_\nu\zeta_\nu$ and the centre distances c_ν multiplied by ζ_ν. The equation permits the computation of the contributions of the

single surfaces to the diapoint errors. The values ϕ_ν are the powers of the different surfaces for the ray. The quantity ϕ_ν is practically equal to the Gaussian power of the surface $(n'_\nu - n_\nu)/r_\nu$, an approximate equality permitting the prediction of the effect of a surface change on the quality of the image. A.

535.317.5 : 535.8

7143. On a new aberration function of optical instruments. E. Wolf. *J. Opt. Soc. Amer.*, **42**, 547–52 (*Aug.*, 1952).

A new characteristic function is introduced which enables an immediate determination of the departures of imaging pencils of rays from homocentricity as well as of the deformations of the associated wave fronts from spherical form. This function is therefore well suited for investigations of aberration effects on the basis of geometrical optics or of diffraction theory. Within the approximations of 4th-order theory, the new function is closely related to the Seidel eikonal of Schwarzschild, but unlike the latter it is defined in simple physical terms and is applicable whether the imagining of a point object or of an extended object is under investigation. The series development of this function is carried out in detail up to 4th order. A.

535.321

7144. Automatic recorder for interferometry and refractometry of streaming solutions (applicable to chromatographic analysis). G. Kegeles and H. A. Sober. *Analyt. Chem.*, **24**, 654–60 (*April*, 1952).

535.33.03 : 536.46

7145. On the validity of anomalous population temperatures in flames. S. S. Penner. Letter in *J. Chem. Phys.*, **20**, 1175–6 (*July*, 1952).

The effect of self-absorption in disturbing rotational and vibrational temperature measurements from OH bands is discussed; Shuler's use of the iso-intensity method may not be valid. A. G. GAYDON

535.33.03 : 536.46

7146. On the validity of spectroscopic temperature determinations in flames. K. E. Shuler. Letter in *J. Chem. Phys.*, **20**, 1176–7 (*July*, 1952).

A reply to Penner (see preceding abstract). For a hydrogen flame, use of the iso-intensity method and Oldenberg's f values for OH indicates equilibrium and no internal inconsistency. A. G. GAYDON

535.33.07

7147. Multiple monochromators. III. A quadruple monochromator and its application to infrared spectroscopy. N. S. Ham, A. Walsh and J. B. Willis. *J. Opt. Soc. Amer.*, **42**, 496–500 (*July*, 1952).

For Pt II, see Abstr. 3454 (1952). The method described previously has been used to convert a conventional monochromator to a quadruple monochromator having much higher resolving power and giving almost complete elimination of scattered radiation. A pair of right-angled mirrors, placed so that the planes in which they lie intersect at the entrance slit, reflects the radiation through the dispersing system several times before passing through the exit slit. Radiation of different orders, and consequently of different wavelengths, passes through the exit slit simultaneously. A chopper is so arranged that only one of these orders, in the present work the fourth, is interrupted. An amplifier tuned to the same frequency as the chopper is used to amplify the signal from the detector, thereby ensuring that only fourth-order radiation gives an output signal. The method is also applicable to the construction of higher order monochromators. The conversion of a Perkin–Elmer infrared spectrometer (Model 12C) to a quadruple monochromator is described and the performance of the instrument is illustrated by typical spectra recorded over the range 3–20 μ. A.

535.33.07

7148. A simple rotating-cell double-beam unit for [single beam] spectrometers. J. D. S. Goulden and S. S. Randall. Letter in *Nature* [*Lond.*] **169**, 1108 (*June* 28, 1952).

Some of the claims of an earlier letter [Abstr. 5649 (1952)] are withdrawn and some modified suggestions are made. G. F. LOTHIAN

535.33.07

7149. An automatic relative-transmission attachment for the Beckman Model DU spectrophotometer. W. Kaye and R. G. Devaney. *J. Opt. Soc. Amer.*, **42**, 567–71 (*Aug.*, 1952).

A relative transmission attachment is described for automatically recording spectra from 210 to 2 700 mμ using a Beckman Model DU quartz spectrophotometer. The attachment requires the use of only one rotating mirror, detector, amplifier, and commutator along with two tuned rectifiers. The ratio of sample to reference beam intensities is traced on a high speed recorder. A slit servo operated from the reference signal maintains a reasonably constant reference signal. Representative curves showing the performance of the instrument are reproduced. The applications of differential recording are discussed. A.

535.33.07 : 535.339

7150. Multiple monochromators. A. Walsh. Letter in *Nature* [*Lond.*] **169**, 976–7 (*June* 7, 1952).

The author replies briefly to criticism of a previous letter [Abstr. 6847 (1951)]. R. W. FISH

535.33.07 : 535.339

7151. A quadruple monochromator. N. S. Ham, A. Walsh and J. B. Willis. Letter in *Nature* (*Lond.*] **169**, 977 (*June* 7, 1952).

An attachment to a normal monochromator is described which allows it to be used as a quadruple monochromator. Typical results obtained from a modified i.r. spectrometer are shown. See also Abstr. 6847 (1951). R. W. FISH

535.33.07–15

7152. An infrared spectrograph for use in the 40–150-micron spectral region. R. A. Oetjen, W. H. Haynie, W. M. Ward, R. L. Hansler, H. E. Schauwecker and E. E. Bell. *J. Opt. Soc. Amer.*, **42**, 559–66 (*Aug.*, 1952).

Problems relating to the design of a far i.r. spectrograph are discussed. The design of a spectrograph which was constructed is described. A Pt strip coated with ThO_2 is used as a source. Discrimination against short-wave radiation is provided by quartz, paraffin, turpentine soot, a compensated KBr chopper, reststrahlen plates, and a grating (used as a reflection filter) with groove separation somewhat less than the

avelength being investigated. As a dispersing evice, an echelette grating ruled with 180 lines per ch is used. The detector is a Golay pneumatic cell. low noise vacuum-tube amplifier renders the signal om the detector suitable for operation of a strip-hart recorder. The spectrograph is evacuable. pectral operating characteristics of the instrument re shown in ammonia and atmospheric water vapour pectra in the region between 45 and 150 microns. bsorption lines separated by less than 1 cm^{-1} are ell resolved throughout this spectral region. A.

535.33.07–15

153. Wavelength calibration of infra-red spectrometers in the wavelength region 15–25 μ and the selection of solvents. L. W. MARRISON. Note in *Sci. Instrum.*, **29**, 233–4 (*July*, 1952).

Lists 25 suitable bands of atmospheric water vapour nd CO_2. A number of solvents have been selected rom tests in a 0·1 mm cell. G. F. LOTHIAN

535.33.07–15 : 535.343.4–15

154. Some accurately measured infrared wavelengths for calibration of grating spectrometers. K. PLYLER, N. M. GAILAR AND T. A. WIGGINS. *J. Res. Nat. Bur. Stand.* [*Wash.*] **48**, 221–7 (*March*, 1952).

The measured values of the wavelengths of 60 lines n the 1·1- to 2·3-micron spectral region are reported. The absorption lines of the bands of methane and water vapour were used in the calibration. The methods of measurement are discussed. Also discussed are the methods of superimposing the well-known emission lines of several sources on the absorption lines that were measured. The values obtained for some lines are compared with values reported by other workers.

535.331

7155. Description and analysis of the second spectrum of chromium, Cr II. C. C. KIESS. *J. Res. Nat. Bur. Stand.* [*Wash.*] **47**, 385–426 (*Nov.*, 1951).

The analysis of Cr II presented in this paper is based on new wavelength measurements and estimated intensities, and on new observations of the Zeeman effect. Of approximately 2 100 lines listed in the tables, 89% have been classified as combinations of the levels of 48 even terms with levels of 51 odd terms. The even terms arise from the electron configurations $3d^5$, $3d^4\,4s$, and $3d^3\,4s^2$, the odd terms from the configuration $3d^4\,4p$. No odd terms from the configuration $3d^3\,4s\,4p$ have been established. High even terms from the excited configurations $3d^4\,4d$ and $3d^4\,5s$ have been found that form Rydberg series with terms from the low even configurations. From them an ionization potential of 16·49 eV has been derived for the work required to convert a singly ionized Cr atom in the $a\,^6S_{2\frac{1}{2}}$ state to a doubly ionized atom in the $a\,^5D_0$ state. The terms of the $3d^3\,4s^2$ configuration lie high in the energy scale, and only a few relatively faint combinations between them and the odd terms have been found. A.

535.331 : 538.615

7156. Asymmetries of Zeeman patterns and g-values for neutral manganese. M. A. CATALÁN. *J. Res. Nat. Bur. Stand.* [*Wash.*] **47**, 502–24 (*Dec.*, 951).

Spectrograms of Mn made with fields in excess of 84 000 oersteds show many lines that exhibit various degrees of distortion in both the positions and the intensities of the magnetic components. The interpretation of these asymmetric patterns has been made by the approximate theory of the partial Paschen-Back effect. The *g*-values that have been derived for several energy levels of Mn I are found to conform, in most cases, with those required for *LS*-coupling. A few exceptions to this rule have been considered in some detail. General tables have been computed, which will permit explanation of the distortions in other spectra. A.

535.331–15

7157. Infrared emission spectrum of calcium. C. J. HUMPHREYS. *J. Res. Nat. Bur. Stand.* [*Wash.*] **47**, 262–8 (*Oct.*, 1951).

The spectrum of neutral Ca excited in a.c. and d.c. arcs, using carbon electrodes cored with CaO, has been observed with high resolution, in the interval between 12 816 and 22 655 Å. A total of 36 lines has been observed, of which all but one have been classified. The long-sought term, $3d^2\,^3F$, has been found and established on the basis of two complete multiplets, $3d4p\,^3F^\circ - 3d^2\,^3F$, and $3d4p\,^3D^\circ - 3d^2\,^3F$, and two intersystem lines $3d4p\,^1D^\circ - 3d^2\,^3F_{2,3}$. Most of the infrared energy is radiated in the multiplet $4p\,^3P^\circ - 3d\,^3D$. These lines are suggested for use as wavelength standards for the 2 μ region. A.

535.332 : 551.593.9

7158. The effect of hydrogen gas on the excitation of auroral green line λ5577 in discharge tubes. M. MIYANISHI AND K. WATADANI. *J. Phys. Soc. Japan*, **7**, 70–2 (*Jan.–Feb.*, 1952).

It was shown previously [Abstr. 4563 (1950)] that, the auroral green line λ5577 observed in the night sky would be excited by the recombination energy of H atoms in the upper atmosphere higher than 300 km. In the present experiment the green line was newly excited in a small capillary discharge tube containing a small quantity of O gas, and in a case of a He discharge tube or Ne discharge tube which was hitherto used to excite the green line, it was especially intensified when H gas was added. A.

535.338.4

7159. Arc spectra of gallium, indium, and thallium. W. F. MEGGERS AND R. J. MURPHY. *J. Res. Nat. Bur. Stand.* [*Wash.*] **48**, 334–44 (*April*, 1952).

The spectra have been systematically investigated photographically in the octave 6 500 to 13 000 Å. The spectra were excited in direct-current arcs and recorded on infrared sensitive photographic emulsions with a concave diffraction grating 22 feet in radius. In the designated spectral range, 37 new lines were photographed in Ga I, 35 lines in In I, and 25 lines in Tl I. All the observed lines are explained as combinations of doublet terms arising from the axial and orbital momenta of a single-valence electron. The new data led to a revision of Ga I terms, and extension from $n = 9$ to 12 for $ns\,^2S$, from $n = 7$ to 11 for $nd\,^2D$, and to the discovery of $nf\,^2F^\circ$ terms from $n = 4$ to 7. Besides confirming many terms already known for In I and Tl I, two new $nf\,^2F^\circ$ terms were found for each of these spectra. A.

535.338.4

7160. The emission of radiation from diatomic gases. IV. Emissivity calculations for CO and HCl for non-overlapping rotational lines as a function of temperature and optical density. S. S. PENNER. *J. Appl. Phys.*, **23**, 825–37 (*Aug.*, 1952).

For Pt III, see Abstr. 3451 (1952). Simplified expressions have been developed for the engineering emissivity of uniformly distributed diatomic gases for non-overlapping rotational lines with a resonance contour. Unfortunately the rotational half-widths for spectral lines arising from transitions between excited vibrational energy levels are generally not known. For this reason it was necessary to make the assumption that the rotational half-widths for transitions of the form $n \rightarrow n + v$, $v = 1$ or 2, are identical. The theoretical analysis is, however, sufficiently general to be useful without modification when accurate data concerning the dependence of line-width on vibrational excitation become available. Explicit expressions have been obtained for the contributions to the total emissivity associated with individual vibration-rotation bands. Representative emissivity calculations have been carried out for CO and HCl. Comparison of the calculated emissivities of CO with experimental data shows only fair agreement, suggesting either that the assumed description of rotational half-widths is inadequate or else that the empirical emissivity data are not reliable at elevated temperatures. A.

535.338.42–15

7161. The infrared emission specta of OH, CO, and CO_2 from 3μ to 5·5μ. E. K. PLYLER AND J. J. BALL. Letter in *J. Chem. Phys.*, **20**, 1178–9 (*July*, 1952).

535.343

7162. Study of the influence of pressure on the Hartley band of ozone. B. MAHMOUDIAN AND E. VASSY. *C.R. Acad. Sci.* [*Paris*] **234**, 2350 (*June 9*, 1952) *In French.*

Pressure changes over a 10 to 1 range have no effect on the absorption coefficients. G. F. LOTHIAN

535.343

7163. Absolute values of absorption coefficient of ozone in the region of the Huggins bands, at 18°. E. VIGROUX. *C.R. Acad. Sci.* [*Paris*] **234**, 2351–2 (*June 9*, 1952) *In French.*

Results of photographic measurements are tabulated. They are found to be independent of pressure over a large range and to be smaller than other published values. G. F. LOTHIAN

535.343 : 539.132

Application of action coefficients to the study of vibration spectra of polyatomic molecules. I–II. *See Abstr.* 7457–8

535.343–15

7164. Infra-red spectra of acetylproline *n*-methylamide and the configuration of a proline residue in a polypeptide chain. S. MIZUSHIMA, T. SHIMANOUCHI, K. KURATANI, M. TSUBOI, T. SUGITA, I. NAKAGAWA, K. KUROSAKI. Letter in *Nature* [*Lond.*] **69**, 1058–9 (*June* 21, 1952).

As this substance shows only one absorption peak (3350 cm^{-1}) in the 3μ region, which represents the hydrogen-bonded NH vibration, it is concluded that all the molecules have a folded configuration, in contrast to acetylglycine *n*-methylamide, which contains folded and extended molecules. Measurements in the 6 μ-region and the calculation of the dipole moment support this statement. A. J. TAYLOR

535.343–15

7165. Infra-red spectrum of some complex fluorides. A. DE LATTRE. Letter in *J. Chem. Phys.*, **20**, 1180 (*July*, 1952).

535.343-15 : 539.132

7166. Rotation-vibration spectra and structure of simple polyatomic molecules. G. HERZBERG. *Nature* [*Lond.*] **169**, 997–1001 (*June* 14, 1952).

A general analysis is given of these spectra, when taken in ordinary i.r. or in photographic i.r. Rotational levels of linear molecules are similar to those of diatomic molecules. If perpendicular vibrations occur, a vibrational angular momentum about the symmetry axis is excited, which causes Σ, Π, Δ, etc., vibrational levels. Σ–Σ bands have *P* and *R* branches, Π–Σ and Π–Π bands have a *Q* branch in addition, which is strong for Π–Σ. A centre of symmetry in the molecule can be detected by the alternation of intensities of successive lines. The rotational constants can be calculated and from them the moment of inertia. For the calculation of atomic distances data of several isotopic molecules are generally necessary. For non-linear symmetric top molecules one distinguishes parallel and perpendicular bands, the former with one, the latter with two sub-bands, for each value of *K* (components of angular momentum along the top axis). Some rotational constants and the moments of inertia can be calculated, but additional data from Raman spectra may be necessary. Spherical top molecules have complicated band structures, as the degeneracy of the levels is removed by Coriolis interaction. Only very few asymmetric top molecules can be investigated. Several illustrative examples are given. A. J. TAYLOR

535.343–32

7167. Polarization of the second ultra-violet system in hexamethylbenzene. D. P. CRAIG AND L. E. LYONS. Letter in *Nature* [*Lond.*] **169**, 1102 (*June* 28, 1952).

From measurements made with a quartz spectrograph using a calcite rhomb transparent to 2150 Å, the polarization of the 2300 Å system of hexamethylbenzene has been studied. This system corresponds to the 2000 Å system in benzene and the results indicate that the polarization is predominantly in the molecular plane. G. I. W. LLEWELYN

535.343.2–12 : 539.133

7168. Quadrupole spectra: aliphatic chlorine compounds. R. LIVINGSTON. Letter in *J. Chem. Phys.*, **20**, 1170–1 (*July*, 1952).

The Cl^{35} pure quadrupole coupling spectra near 40 Mc/s are observed at 20°K and 77°K for various chlorinated derivatives of ethane, propane, etc. The order of the coupling constants is related to the ionic character of the C–Cl bond, the order of ionicity being $(CH_3)_3CCl > (CH_3)_2CHCl > CH_3CH_2Cl > CH_3Cl$ etc. D. H. WHIFFEN

535.343.2–15

69. Influence of temperature on infra-red spectra solid paraffins in the region of 700 cm^{-1}. L. ROBERT D J. FAVRE. *C.R. Acad. Sci.* [*Paris*] **234**, 2270–2 *ne* 4, 1952) *In French.*

Solid paraffins show two absorption bands in this gion, at 721 cm^{-1} and 732 cm^{-1}; the latter does t occur in the liquid phase. It is found that this nd appears several degrees below the melting point. this point there is a crystalline transition from nexagonal into an orthorhombic phase.

A. J. TAYLOR

535.343.3/.4–15

70. Infrared spectra of methanol, ethanol, and propanol. E. K. PLYLER. *J. Res. Nat. Bur. Stand. Vash.*] **48**, 281–6 (*April*, 1952).

535.343.32

71. On the spectra of praseodymium and neo- mium in organic solutions. C. TURNER-POLENAAR. *nsterdam Diss.*, 62 *pp.* (1952) *In Dutch. Summary p.) in English.*

Solutions of acetyl-acetonate in methyl and ethyl cohols, benzene, acetone and carbon tetrachloride re examined with a view to determining the effects solvent and temperature. Results were in agree- ent with earlier observations, and some new bands re found. The absorption of Pr··· in acetone ems to be intensified at −70°C, which may be due a decrease in the symmetry of the fields. Oscillator engths of some of the bands of $NaCl_3$ and $PrCl_3$ in ter are calculated. The possible reasons (e.g. lvation, polymerization) for the variations in the ectra are discussed on the basis of existing theories.

535.343.4

72. On a visible spectrum observed in acetylene, ylene and aromatic molecules. H. SCHÜLER AND REINEBECK. *Z. Naturforsch.*, **7a**, 285–9 (*March–ril*, 1952) *In German.*

The method of obtaining spectra by variation of ctron velocities in the positive column of a glow scharge is applied to acetylene, ethylene, benzene, phthalene and several other aromatic compounds. ey all show a common "T" spectrum in the visible nge, which must be due to C_2H, C_2H_2 or C_2H_3 oups. The experimental conditions are also scribed.

A. J. TAYLOR

535.343.4–14

73. [Review of] spectroscopy in the region of milli- tre waves. M. MATRICON. *Rev. Tech.C. F. T. H.*, . 16, 7–20 (*Dec.*, 1951) *In French.*

535.343.4–15

74. Near infrared absorption spectra of uterated acetylene. E. K. PLYLER AND N. GAILAR. *Res. Nat. Bur. Stand.* [*Wash.*] **47**, 248–51 (*Oct.*, 51).

The bands of C_2D_2 at 1·96 and 2·39 μ have been easured under high resolution so that the moments inertia of this molecule could be compared with at of C_2H_2 and C_2HD. From the measurement the rotational structure the ground rotational nstant, B_0, is found to be 0·8471 cm^{-1}. The centre the $\omega_1 + \omega_3$ band is 5097·07 cm^{-1}, and the centre $\omega_2 + \omega_3$ is 4190·46 cm^{-1}. A.

535.343.4–15

7175. Infrared absorption spectra of five halo- methanes. E. K. PLYLER AND N. ACQUISTA. *J. Res. Nat. Bur. Stand.* [*Wash.*] **48**, 92–7 (*Jan.*, 1952).

535.343.4–31

7176. Spectroscopic studies in the near ultraviolet of the three isomeric dimethylbenzene vapors. II. Absorption spectra of meta and ortho dimethylbenzene. C. D. COOPER AND H. SPONER. *J. Chem. Phys.*, **20**, 1248–58 (*Aug.*, 1952).

For Pt I, see Abstr. 5033 (1952). The vapour absorption spectra of meta- and ortho-xylene were obtained with a 3 meter grating spectrograph. The *m*-xylene spectrum has the least number of bands and the most diffuse appearance. Its 0, 0 band is located at 36 955 cm^{-1}. The *o*-xylene spectrum consists of many very sharp bands several of which must be assigned to $v - v$ transitions. Its 0, 0 band is found at 37 308 cm^{-1}. Vibrational frequencies of 965, 675 and 470 cm^{-1} are found in the upper level of the meta-spectrum and are correlated with the ground-state frequencies of 995, 725 and 510 cm^{-1}. In the ortho spectrum ground-state vibrational frequencies of 1233, 1054 and 736 cm^{-1} are correlated with the excited state values 1195, 939 and 692 cm^{-1}, respectively. Assignments of the different frequencies are discussed. The Tesla luminescence spectrum of meta-xylene is interpreted along with the absorption spectrum. A.

535.345

7177. Spectroscopic study of amethyst quartz in the visible region. M. K. V. BAPPU. *Indian J. Phys.*, **26**, 1–14 (*Jan.*, 1952).

A detailed study is made of the absorption of light in the visible region by amethyst quartz. An absorption band (the so-called *F*-band) decreases in intensity at high temperature, while the maximum also shifts towards longer wavelengths; but the number of colour centres remains constant till about 200°C. At higher temperatures these centres, which are responsible for the absorption, are destroyed by heat. When the crystal is exposed to radiation absorbed by the *F* band, a new *F'* band appears. The facts reveal that the coloration is due to exposure to some penetrating radiations. A.

535.345

7178. Extinction effect in powders. R. J. WEISS. Letter in *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 553–5 (*July*, 1952).

The theoretical expressions for primary and secondary extinction are compared with experimental points. Both apply equally well. C. TURNER

535.345.1–15 : 548.5

7179. Growth and infrared transmission of cesium iodide crystals. E. K. PLYLER AND F. P. PHELPS. Letter in *J. Opt. Soc. Amer.*, **42**, 432–3 (*June*, 1952).

The preparation from caesium bromide is described. The transmission is shown to be about 85% in the wavelength range 1μ–40μ. A. R. STOKES

535.345.1–32

7180. An alkaline solution of potassium chromate as a transmittancy standard in the ultraviolet. G. W. HAUPT. *J. Opt. Soc. Amer.*, **42**, 441–6 (*July*, 1952).

The need for a means of testing the reliability of the

photometric scale of spectrophotometers in the ultraviolet region (where glasses are unsuitable) has led to the study of an aqueous solution of potassium chromate having the following composition: 0·0400 g per litre of K_2CrO_4 in 0·05 N KOH. Based on extensive measurements using photographic, photoelectric, and visual spectrophotometry, standard values of spectral transmittancy have been determined for 1·000 and 2·000 cm of solution at 25°C from 220 to 500 mμ. These values have been tabulated along with derived values of absorbancy, molar absorbancy index a_M and $\log_{10}a_M$. The latter values have been compared graphically with those of other observers. Changes in spectral transmittancy with changes in temperature have been determined. The investigation has also included a study of the effects due to the container bottle and to age of solutions over periods up to eight years, and a comparison of results obtained with the solution prepared either from K_2CrO_4 or from $K_2Cr_2O_7$ as one of the reagents. A.

535.371

7181. Preparation of plastic scintillation phosphors. G. G. Eichholz and J. L. Horwood. Note in *Rev. Sci. Instrum.*, **23**, 305 (*June*, 1952).

A method for the pressure moulding of polystyrene plastic phosphors is described in detail and shown to be simpler than the casting process. G. F. J. GARLICK

535.371

7182. A study of the electron traps in zinc sulfide phosphor. A. W. Smith and J. Turkevich. *Phys. Rev.*, **87**, 306–8 (*July* 15, 1952).

The thermoluminescence characteristics of a hexagonal ZnS phosphor, Cu-activated, were measured as a function of the wavelength of the exciting light. The glow curve had maxima at 120, 220 and 280°K. It was found that the heights of these maxima at saturation varied with the wavelength of the exciting light, reaching the greatest values at 4 270 Å for the 120° K maximum, 4 400 Å for the 220°K maximum, and 4 500 Å for the 280°K maximum. When the sample was irradiated with 4 400 Å light for a definite time interval and then irradiated with monochromatic radiation of either shorter or longer wavelength for another time interval, it was found that the subsequently measured glow curve showed a decrease in the heights of the maxima from that with 4 400 Å light alone. Since the glow curve can be interpreted as a process of emptying electrons from traps, the above results are interpreted to mean that light which is capable of filling the traps is also capable of stimulating electrons out of the traps. There is a long wavelength limit beyond which irradiation does not affect electrons present in traps. It is 0·7 micron for the trap represented by the 280°K maximum. A.

535.371 : 621.327.43

7183. Influence of temperature on the colour properties of the type TB fluorescent lamp. N. V. Gorbachev and N. S. Ivanova. *Zh. Tekh. Fiz.*, **21**, 1029–34 (*No.* 9, 1951) *In Russian.*

An experimental investigation of a change of colour in the direction pink to yellow of the type TB ("warm white") fluorescent lamp, over the ambient temperature range 25–65°C, showed the cause of the change to be a change in the emission of the $ZnBe(SiO_3)$ phosphor, combined with a relative intensification of emission of the Hg vapour. F. QUELON

535.371 : 771.34

Low temperature fluorescence of silver halides and photographic emulsions. *See Abstr.* 7842–3

535.375.1 : 548.736.5

7184. On the structure of phosphors of the aluminium oxide–calcium fluoride type activated with manganese. G. Günther and H. Perlitz. *Ark. Kemi*, **3**, 565–9 (*Paper* 61, 1952).

X-ray diffraction studies of the Al_2O_3–CaF_2–Mn phosphors show that by preparation at temperatures above 1 100°C a new β-phase 5 Al_2O_3–CaF_2 occurs. Above 1 400°C a γ-phase occurs which is not luminescent. With other activators (e.g. vanadium and uranium) the β-phase is not luminescent.

G. F. J. GARLICK

535.375.5

7185. Novel views on the Raman spectrum of calcite. R. Aynard. *C.R. Acad. Sci.* [*Paris*] **234**, 2352–4 (*June* 9, 1952) *In French.*

An attempt is made to interpret anomalies observed in the Raman spectrum of calcite. G. I. W. LLEWELYN

535.375.5

7186. Dependence of the intensity of Raman spectrum lines upon the frequency of exciting light. A. Kh. Khalilov and P. P. Shorygin. *Dokl. Akad. Nauk SSSR*, **81**, 1031–3 (*No.* 6, 1951) *In Russian.*

The ratios of the intensities of band maxima for multiple bonds of ethyl cinnamate, styrene, benzonitrile, nitrobenzene, and crotonaldehyde to that of the 1 442 band of cyclohexane were determined microphotometrically. It was found that, even in the visible region, the law $I \propto (\nu_{exc.}-\nu_{vibr.})^4$ is not obeyed for compounds with conjugated multiple bonds. F. LACHMAN

535.375.5

7187. On the theory of the Raman effect. F. C. Roesler. *Acta Phys. Austriaca*, **5**, 477–95 (*No.* 4, 1952) *In German.*

It is pointed out that the scatterer (molecule or lattice vibration of a crystal) is strongly coupled to its surroundings, and that this interaction may produce effects which should be taken into consideration in a detailed theory of the Raman effect. In particular there must be a broadening of the lines, increasing with temperature. The interaction may perhaps cause also the observed change with temperature of the intensity at the centre of the lines. All these considerations are largely qualitative. L. PINCHERLE

535.375.5

7188. Rotational wings of Raman bands and free rotation in liquid oxygen, nitrogen, and methane. M. F. Crawford, H. L. Welsh, and J. H. Harrold. *Canad. J. Phys.*, **30**, 81–98 (*March*, 1952).

Rotation-vibrational Raman bands have been observed in liquid O, N and CH_4, and in solid CH_4. In every case the Q branches associated with isotropic Raman scattering are sharp lines; but the Q branches and rotational wings associated with anisotropic scattering form broad continuous bands, with extent and intensity distribution consistent with free molecular rotation. The lack of discrete structure in the

broad bands is attributed to a removal of the *m* degeneracy of the rotational energy levels in the intermolecular force fields. Removal of the *m* degeneracy broadens those transitions for which the transition probability depends on the anisotropic part of the rate of change of the polarizability, but not those for which *J* and *m* are unchanged and for which the transition probability depends only on the isotropic part. The Raman spectrum of liquid O yields no evidence for O_4 aggregates. The Raman spectrum of liquid CH_4 displays all fundamental vibrations of the molecule and two overtones, with Raman shifts (in cm^{-1}): 1300, band (ν_4); 1535, band (ν_2); 2570, line, and 2600, band ($2\nu_4$); 2906, line (ν_1); 3020, band (ν_3); 3053, line ($2\nu_2$). A.

535.375.5

7189. Density effects in the Raman spectrum of carbon dioxide. H. L. Welsh, P. E. Pashler and B. P. Stoicheff. *Canad. J. Phys.*, **30**, 99–110 (*March*, 1952).

Two Raman tubes, one of quartz and one of glass, capable of withstanding pressures up to 75 and 300 atm. respectively, were used to study density effects in the Raman spectrum of CO_2. The components of the ν_1 band show changes in frequency and relative intensity with increasing density. An analysis shows that the frequency changes are due to a lowering of the frequency of $2\nu_2$, in Fermi resonance with ν_1, with increasing density. The intensity effect, however, is not completely explained by the change in the sharpness of the resonance. In the high pressure gas and in the liquid faint bands corresponding to the Raman inactive frequencies, ν_2 and ν_3, are observed. The effect of increasing density on the rotational Raman spectrum can be explained in terms of the broadening of anisotropic scattering by intermolecular forces. A.

535.375.5

7190. The fundamental frequencies of the ClO_2^- ion. J.-P. Mathieu. *C.R. Acad. Sci.* [*Paris*] **234**, 2272–4 (*June* 4, 1952) *In French.*

Raman spectra of a single crystal and solution of $NaClO_2$ give frequencies for the ClO_2^- ion of 790, 400 and 840 cm^{-1}; these accord with angle O–Cl–O = 110° and force constants $4{\cdot}35\times10^5$ and $0{\cdot}53\times10^5$ dyne/cm. G. F. Lothian

535.375.5

7191. The Raman spectra of ethoxychlorosilanes. H. Murata. Letter in *J. Chem. Phys.*, **20**, 1184 (*July*, 1952).

The spectra of $C_2H_5OSiCl_3$, $(C_2H_5O)_2SiCl_2$ and $(C_2H_5O)_3SiCl$ are tabulated and tentative assignations of the observed lines made. G. I. W. Llewelyn

535.375.54

7192. Raman effect in a crystal of heavy ice. E. F. Gross and B. I. Valkov. *Dokl. Akad. Nauk SSSR*, **81**, 761–3 (*No.* 5, 1951) *In Russian.*

Heavy ice has been found to yield Raman frequencies of 2690, 2500, 2445, 2330, 275, 256, 236, 218, 203 and 166 cm^{-1}. The 2445 frequency is not found in heavy water, nor in light water or light ice. In the low-frequency range, the line 203 is very prominent and corresponds undoubtedly with the 213 line of the light ice. This is borne out by calculation based on the assumption that the frequencies 203 and 213 are due to the translational vibrations of H_2O and D_2O molecules in the lattices of ice crystals. In the range 300–150 cm^{-1}, the squares of the ratios of corresponding frequencies of the H bond for crystals of D_2O and H_2O are approximately equal to the mass ratio $M_{H_2O} : M_{D_2O}$. F. Lachman

535.376

7193. Decay times, fluorescent efficiencies, and energy storage properties for various substances with gamma-ray or alpha-particle excitation. L. Bittman, M. Furst and H. Kallmann. *Phys. Rev.*, **87**, 83–6 (*July* 1, 1952).

The results of measurements of the decay time of light flashes induced by γ-ray quanta, or α-particles by means of pulse distribution curves for various crystals, powders and solutions are presented. The decay of organic substances can be described essentially by a single exponential; in addition, a small more slowly decaying portion is present. The decay of inorganic crystals can be represented by a sum of exponentials with time constants in different ranges. The results support a previous explanation of the lower efficiency of α-particles in producing fluorescence when compared to γ-rays. Results on various activated inorganic crystals of integrated fluorescent light output under γ-rays and peak height measurements under γ-ray and α-particle bombardment are also presented. The relative integrated and peak height properties are not well correlated, neither are the responses to γ-rays and α-particles. Such variations are associated with the different emission times of the crystals. It is found that CsBr and CsI activated with Tl are excellent crystals with respect to luminescent properties especially when volume is a factor. The capability of these crystals to store energy to be released later as light by light of longer wavelengths is also indicated. Very good storage and stimulation properties are shown only by NaCl crystals activated with AgCl. A.

535.376

7194. Induced conductivity and light emission in different luminescent type powders. H. Kallmann and B. Kramer. *Phys. Rev.*, **87**, 91–107 (*July* 1, 1952).

The currents induced in various (Zn : Cd)S luminescent-type powders by u.v. radiation have been investigated as well as the quenching and stimulating effects due to i.r. radiation. Similar experiments on the fluorescent emission have also been carried out. Currents induced in these powders by high-energy particle radiation is also described. A model is proposed which contains two types of electron traps, deep traps and shallower traps (which are associated with the emission levels at the activator), and a coupling between the deep traps and the emission levels is assumed. Theoretical calculations based on this model are compared to the experimental results for stationary and nonstationary behaviour. This comparison shows that in all (Zn : Cd)S powders investigated, traps exist from which so-called "direct transitions" to the activators occur with negligible contribution to the conductivity. These transitions may not be radiative, and they also occur in materials which exhibit no noticeable light-stimulation by i.r. radiation. A.

535.376

7195. Electroluminescence of single crystals of ZnS : Cu. W. W. PIPER AND F. W. WILLIAMS. Letter in *Phys. Rev.*, **87**, 151–2 (*July* 1, 1952).

Electroluminescence is observed when a.c. or d.c. fields are applied to ZnS–Cu crystals. The light output increases proportionally with the current through the crystal, but rises exponentially with the applied voltage. The region near the cathode is the seat of the emission. At lower voltages the pulses of emission are out of phase with the field and their relative width is independent of frequency from 60–6000 c/s. At higher voltages other pulses occur in phase with the field. A tentative theoretical explanation of the effects is given. G. F. J. GARLICK

535.39

7196. Measurement of reflecting powers approaching unity for monochromatic light at normal incidence. J. ROIG AND E. COLLET. *C.R. Acad. Sci.* [*Paris*] **234**, 2179–81 (*May* 26, 1952) *In French.*

The total light reflected after multiple reflection is compared with the original intensity by using a Nicol prism to regulate the intensity. The reflection factor is calculated by a formula in which intensities, not amplitudes, are added. N. CORCORAN

535.39

7197. Analysis of goniophotometric reflection curves. I. NIMEROFF. *J. Opt. Soc. Amer.*, **42**, 579–83 (*Aug.*, 1952).

Surface appearance, apart from texture, is defined by the goniophotometric curve giving the angular distribution of the reflected light. A summary of current goniophotometric techniques shows that essential parts of these fundamental data have been neglected. This paper applies an established method of statistics to the problem of goniophotometric-curve analysis and interpretation whereby such data are reduced to dispersion, skewness and kurtosis indexes. The kurtosis index is shown to correlate better with subjective estimates of the distinctness of the reflected images than the conventional measure, 60° specular gloss. The kurtosis index is applied to one problem in the selection of optimum glossmeter geometry. A.

535.39 : 535.417

7198. On the optics of thin doubly refracting and dichroic layers. H. SCHOPPER. *Z. Phys.*, **132**, 146–70 (*No.* 2, 1952) *In German.*

The procedure for the determination of the optical constants and thickness of absorbing layers from phase and intensity measurements, ignoring internal multiple reflections, has been given previously for normal incidence [Abstr. 5311 (1951); 931, 1672, 3494 (1952)]. The present paper considers the multiple reflections and obtains equations for complex amplitudes, the absolute phase, and intensity for reflection and transmission at oblique incidence for an anistropic layer. Initially the general equations are given from which it follows that the layer can be optically uni- or bi-axial, but one optical axis of symmetry must be perpendicular to the plane of the layer. It is shown how the optical constants and the layer thickness are obtained from the absolute phase. Very thin ($d \ll \lambda$) and moderately thick layers are treated in detail. Försterling's procedure for the determination of optical constants using relative phase measurements (1937) is not applicable for anisotropic layers, but it is shown that the layer thickness can be found from these measurements by a simplification of the Essers–Rheindorf method (1937) if the optical constants are known. H. G. JERRARD

535.39 : 551.578.4

7199. The luminous directional reflectance of snow. W. E. K. MIDDLETON AND A. G. MUNGALL. *J. Opt. Soc. Amer.*, **42**, 572–9 (*Aug.*, 1952).

By means of a specially constructed portable goniophotometer the directional reflectance of numerous surfaces of snow was measured during the winter of 1951–1952. While some samples reflected more nearly diffusely than others, all showed much specular reflection at high angles of incidence. An approximate theory of the specular reflection is given and its results compared with experiment. The experimental fact that the angle of maximum reflectance is greater than the angle of incidence is explained by the theory. A.

535.39 : 679.5 : 628.94

7200. Optical properties of some opal acrylic plastics. W. E. HARPER. *Comm. Int. Eclair.* [*CE*] *12th Mtg*, 1951. *Volume* 2, *Paper A*, 13 *pp.* (1952).

The use for lighting purposes of opal forms of the acrylic plastic polymethyl methacrylate is increasing. There are two kinds: in one, the particles giving the diffusion are of an inorganic pigment; in the other an organic polymer, soluble in the matrix, is precipitated during polymerization. The author gives, for specimens of each type, the four quantities needed to determine the behaviour of a diffusing material, viz. the transmission and reflection factors, the scattering coefficient and the diffusion factor. The methods used for making the necessary measurements are described and the results are interpreted on Ryde and Cooper's theory (1902). J. W. T. WALSH

535.393 : 535.33–31

7201. Spectral reflection of metals in the spectra region 220–250 mu. T. G. POROKHOVA. *Zh. Tekh. Fiz.*, **22**, 308–12 (*No.* 2, 1952) *In Russian.*

Absolute reflection spectra are measured with a Beckmann ultraviolet spectrometer by a comparison method using an internally reflecting quartz prism. The results are given graphically from 500–220 mμ for polished blocks of Ag, Fe, Cu, Ni, W, Mo, Cr, Mn, Nb, Ta, Zn, Cd, Mg, Al, Si, Sn, Pb, C, Sb, Bi, Te and Se. Mo and Si only show over 50% reflection below 300 mμ. D. H. WHIFFEN

535.41 : 535.323 : 535.3

7202. Optical constants of ZnS films. G. KUWABARA AND K. ISIGURO. *J. Phys. Soc. Japan*, **7**, 72–(*Jan.–Feb.*, 1952).

These were determined by photometric and interferometric methods for the wavelength between 400 mμ and 1000 mμ. The results obtained by both methods agree within experimental error, and the density of the film calculated by Lorenz–Lorenz formula is c. 0·98 of that of the bulk ZnS. A

535.41 : 535.3

7203. On the lamellar reflectivity and phase shift for multiple reflections. S. NAWATA. *J. Phys. Soc. Japan*, **7**, 75–8 (*Jan.–Feb.*, 1952).

An expression for calculating the lamellar reflectivity of a single layer on a surface of metal is given

by extending Nathanson and Bartberger's equation. Then, interpreting this expression as reflectivity for a surface of hypothetical medium with an "effective refractive index," the reflectivity and the phase shift due to the reflection of two or more thin films on a surface of metal were calculated and the results were compared with the experiments of A. F. Turner (1946) and G. Hass (1949). It was ascertained that the results of calculation show a good coincidence with the experimental data, except in the case of very thin Al film, in which the optical constants different from those of bulk Al must be used. This method of calculation is useful for producing interference filters, and reflection increasing or reducing by multilayer films, etc. Finally, from the result of the calculation, a method of obtaining a reflection-type interference filter using ZnS was induced. A.

535.417

7204. Experimental verification of source size theory for the Mach–Zehnder interferometer. G. D. Kahl and F. D. Bennett. *J. Appl. Phys.*, **23**, 763–7 (*July*, 1952).

The simplified theory of the Mach–Zehnder interferometer developed by the latter author is tested. The reduction in the visibility of fringes formed by the interferometer due to an extended area light source is shown experimentally. This reduction is shown to be caused by the superposition of two separate effects which are characteristic of the two angular co-ordinates of the unit vector pointing from the centre of the collimating lens toward each point in the plane of the area-type source. The relation of each of the effects to that co-ordinate characterizing it is demonstrated experimentally to agree with the theory. The result of combining these two effects from all of the points of an area-type source is experimentally seen to cause the "focusing" of the visible fringes and to limit them to a finite region of the intersecting beams determined by the size and shape of the source. A.

535.417 : 531.717.8

Thin-film interferometric techniques for high magnification topographical studies. *See Abstr.* 7058

535.42 : 548.732

7205. Diffraction geometry. K. L. Yudowitch. *J. Opt. Soc. Amer.*, **42**, 437–40 (*July*, 1952).

An error-minimizing geometry is deduced for a three-aperture diffraction system. All aperture dimensions and the aperture separation are absolutely determined from initial knowledge of (1) the specimen-detector separation, (2) the diffraction angle, and (3) the tolerable geometric error. Examples of patterns obtained with such optimum systems are compared with typical non-optimum systems to show the improvement in resolution. A.

535.434 : 541.182.5.025

Light scattering by some thixotropic gels. *See Abstr.* 7641

535.55

7206. Photo-elastic determination of boundary stresses. W. Shelson. Letter in *Nature* [*Lond.*], **170**, 82–3 (*July* 12, 1952).

Details are given of a method for the determination of the stress at a point in the surface of a model in which the surface itself acts as an analyser. The surface must be unpolished. The experimental arrangement is shown and a photograph of fringes obtained at the tension edge of a beam in pure bending is given. H. G. Jerrard

535.65

7207. Specification of light sources by the spectral-band method. A. A. Kruithof. *Comm. Int. Eclair.* [*CIE*] *12th Mtg*, 1951. *Volume* 2, *Paper V*, 12 *pp.* (1952).

An examination of the method of describing the colour of a light source by the radiation in 8 spectral bands, with particular reference to the bands provisionally adopted by the C.I.E. The author states the conditions which should be satisfied if the method is to give an adequate criterion of the colour rendering properties of a light. An alternative system of 8 bands is considered. J. W. T. Walsh

535.68

7208. Colour adaptation and the subjective appearance of colours. W. D. Wright. *Comm. Int. Eclair.* [*CIE*] *12th Mtg*, 1951. *Volume* 2, *Paper G*, 6 *pp.* (1952).

Colorimetry gives a colour specification of a light, irrespective of the adapting conditions which, in fact, alter an observer's appraisal of a colour. To obtain a quantitative description of the subjective appearance of colours it is necessary to have standard viewing conditions for the reference system. The author suggests standard illuminant A, colour of surround neutral with luminance factor 0·75 and angular subtense 15°, illumination of 10 lm/ft², eye adapted to luminance of surround. The most promising method of comparing the test and reference colours is by binocular matching. J. W. T. Walsh

535.7 : 612.84

Physiological optics. *See Abstr.* 7769–79

535.822.9

7209. On the effects of errors of micoid disc in polanret microscope. H. Nakamura and H. Kubota. *J. Phys. Soc. Japan*, **7**, 79–83 (*Jan.–Feb.*, 1952).

According to the theory, it is expected that the phase difference and the intensity ratio of the diffracted and the direct rays of the polanret microscope may be varied to any desired values, independently of each other. But, this is permissible only when there is no error of manufacture in the micoid disk of the microscope. If the errors of this disk are taken into account, the above assumption is no longer true. It was found that the effect of error in the $\lambda/4$-plate (deviation of retardation from $\lambda/4$) upon the intensity ratio becomes maximum when the phase difference is $\pi/2$. This is the worst effect, as the polanret microscope is used at $\pi/2$ most frequently. All other effects become zero or minimum when the phase difference is $\pi/2$. Graphs showing the results of calculations are given to determine the limits of the tolerable errors in the micoid disk. A.

535.822.9

7210. High-speed counting with the flying spot microscope. F. Roberts and J. Z. Young. Letter in *Nature* [*Lond.*] **169**, 963 (*June* 7, 1952).

A modification to the flying spot technique [Abstr.

3473 (1951)] is described which ensures correct counting of particles in the microscope field. Counts at a speed of 10^6 a second with an error $<1\%$ have been made. R. W. FISH

535.822.9 : 535.41

7211. Interference microspectroscopy. R. BARER. Letter in *Nature* [*Lond.*] **170**, 29 (*July 5*, 1952).

Light from an interference microscope is projected on to the entrance slit of a spectrograph. A series of dark bands then cross the spectrum and the displacement of these bands by any object in the field allows its phase change to be determined. The contrast of the bands is much greater than that of the interference fringes and the absorbing properties may also be observed. A sample photograph is shown.

R. W. FISH

HEAT 536

536.1

7212. Approximate formulae in the theory of thermal regenerators. B. H. SCHULTZ. *Appl. Sci. Res. A*, **3**, 165–73 (*No.* 3, 1952).

The application of Hausen's theory (1929) for the temperatures and efficiency of regenerators involves very laborious computations. It is shown that for some limiting cases more simple formulae can be found with the aid of a perturbation theory. The formulae are series expansions for the fluctuating temperatures and the efficiency in terms of the reduced surface Λ and the reduced heat capacity Γ of the regenerator for the case of $\Gamma \gg 1$ and for the case of $\Lambda \ll 1$, for balanced load conditions. A.

536.2

7213. The contribution of radiation to the conduction of heat. E. F. M. VAN DER HELD. *Appl. Sci. Res. A*, **3**, 237–49 (*No.* 3, 1952).

Measurements of the thermal conductivity by stationary and non-stationary methods are liable to give different results, in particular at high temperature. The cause of this discrepancy can be found in a contribution of radiation to the conduction of heat. Instead of Fourier's differential equation an integro-differential equation and an integral equation are obtained. Solutions are given for the steady state, for the source functions and for problems which can be solved by separation of variables. Some applications are also given. A.

536.21

7214. On the mathematical analysis of the problem of the heat conduction with the variable transfer coefficient. T. SATOH. *J. Phys. Soc. Japan*, **7**, 245–9 (*May–June*, 1952).

The integro-differential equation for the temperature $v(x, t)$ of an infinite cylinder, which is kept at const. temperature initially, and loses heat by the radiation from its surface with variable transfer coefficient $h(t)$ is set up as follows:

$$V(x,t) = H(t)\sqrt{x} - \frac{\partial}{\partial t}\int_0^1 G^*(x,s)V(s,t)ds,$$

$$V(x,t) = \sqrt{x}\,v(z,t).$$

The surface temperature $H(t)$ is determined by the relations

$$\frac{1}{2}\int_0^t H(t)dt - \int_t^\infty P(t)dt - \int_0^t P(t-s)H(s)ds + \frac{1}{32} = \frac{1}{2}t - \int_0^t (t-s)H(s)h(s)ds,$$

where $P(t) = 2\Sigma \exp(-\lambda_n^2 t)/\lambda_n^2$, from which further relations between $H(t)$ and $h(t)$:

$$P(t) - \int_0^t P'(t-s)H(s)ds = \frac{1}{2} - \int_0^t H(s)h(s)ds,$$

and

$$H(t)h(t) = \int_0^t H'(t-s)P'(s)ds,$$

are obtained. It is shown that in the special case where $h = \text{const.}$ known results can be obtained from these relations. The Fourier transforms of $H(t)h(t)$, $H(t)$ and $V(x, t)$, denoted by $K^*(\zeta)$, $H^*(\zeta)$ and $V^*(x, \zeta)$ respectively, are found to satisfy

$$V^*(x,\zeta) = [\sqrt{x}J_0(kx)/J_0(k)][H^*(\zeta) + (\sqrt{x}/\sqrt{2\pi})]\{[J_0(kx) - J_0(k)]/k^2J_0(k)\},$$

$$K^*(\zeta) = \left[i\zeta H^*(\zeta) + \frac{1}{\sqrt{2\pi}}\right] J_1(k)/kJ_0(k),\ i\zeta = k^2.$$ A.

536.21 : 536.48

7215. Thermal conductivity of metals at low temperatures. E. H. SONDHEIMER. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 562–4 (*July*, 1952).

The discrepancies between recent experimental values of thermal conductivity of various metals at low temps. and the predictions of the theory of Makinson and Sondheimer are discussed. It is shown that the theory is not valid for all values of the parameter D/ζ and that the assumption of an abnormally small number of conduction electrons is not admissible. The temp. variation of thermal conductivity κ is a more searching test of the theory than that of electrical conductivity which is independent of D/ζ. It is concluded that a substantial modification of the formula for κ is necessary.

W. C. MOSS

536.21 : 537.311.31

7216. An investigation of the validity of the Wiedemann–Franz–Lorenz law. J. O. LINDE. *Ark. Fys.*, **4**, 541–54 (*Paper* 38, 1952).

Published data on the thermal conductivity of metals and alloys are critically examined, the transition metals being excluded. For pure metals, it is found that the electronic thermal conductivity (obtained by applying a correction to measured values to account for lattice conductivity) is practically independent of the temperature at temperatures which are not too low. For alloys, the WFL law is found to be obeyed by that part of the electrical resistivity which is independent of temperature but not by that part due to atomic vibrations. A relation is suggested which takes into account the different temperature dependence of the two parts of the thermal resistivity (due to atomic vibrations and solute atoms) of an alloy which is complementary to Matthiessen's law for the electrical resistivity. M. R. HOPKINS

536.21 : 537.311.32

7217. Thermal and electrical conductivities of carbon materials. S. MIZUSHIMA. Letter in *Phys. Rev.*, **86**, 040 (*June* 15, 1952).

Heat treatment over a temp. range 1300–2500°C of carbon prepared from pitch coke showed that the rise of crystallite size in the *hk*O direction to correspond to the rise in thermal conductivity, and that in the *hkl* direction to correspond to the rise in electrical conductivity. Solid carbon samples prepared from pitch coke, formaldehyde resin and charcoal showed nearly the same, and const. resistivity after heating in the range 1500–1900°C. W. C. MOSS

536.212.3.08

7218. A transient heat flow method of determining thermal conductivity: application to insulating materials. C. P. LENTZ. *Canad. J. Techn.*, **30**, 53–66 (*June*, 1952).

When the line heat source [Abstr. 1699 (1950)] was incorporated in a probe of a form considered suitable for use in insulating materials, results were found to be highly dependent on heat conduction through power and thermocouple leads, and on other factors in probe construction. Conductivities measured in rock wool (10 lb/ft³) were 10 to 15% lower than accepted hot plate values, except when heat loss through end leads introduced a compensating error. Results from four tests under similar conditions agreed within a ±3% range. An unenclosed wire heater gave good results with granulated and blanket rock wool, silica aero-gel and slab cork. A heater wire of very small diameter (0·01 in) had to be used with insulation of low density (2 lb/ft³). Conductivities obtained varied linearly with heater current. There was no significant difference between results with the heater wire in horizontal and vertical positions. Results from four unenclosed wire heater tests under similar conditions fell within a ±1·5% range. A.

536.25 : 551.513 : 523.16

Convection under terrestrial and astrophysical conditions. *See Abstr.* 6993

536.42.08

7219. An automatic thermal analyses recorder. R. L. CUNNINGHAM, H. M. WELD AND W. P. CAMPBELL. *J. Sci. Instrum.*, **29**, 252–3 (*Aug.*, 1952).

An inverse rate recorder is described that can detect thermal effects to within 0·2°C. The instrument employs a standard commercial potentiometer and several common electronic circuits. The record produced consists of a series of straight lines. The position of each line represents a set temperature while the length of the line represents the time the sample required to change from the previous temperature. A.

536.421.1

7220. Melting phenomena of a surface of monomolecular thickness. D. E. BEISCHER. *Science*, **115**, 582–4 (*June* 20, 1952).

The preparation of radioactive C^{14} stearic acid monolayers on a slightly scratched mica surface is briefly described. The specimens were heated in a Cu block oven and the temperature at which the two-dimensional lattice of the monolayers becomes unstable, as indicated by the surface diffusion of the tagged molecules to the scratches which then become visible in the radioautographs, was noted. The temperature of the phase transition was below the normal melting point of the stearic acid and was not sharp. The method is claimed to be very sensitive. An explanation on the basis of Lennard-Jones and Devonshire's theory of the melting process is briefly attempted. S. WEINTROUB

536.421.1 : 532.614.2

Surface tension and melting point. *See Abstr.* 7075

536.423.15

7221. Vapor pressures of inorganic substances. VIII. Molybdenum between 2151 and 2462°K. J. W. EDWARDS, H. L. JOHNSTON AND P. E. BLACKBURN. *J. Amer. Chem. Soc.*, **74**, 1539–40 (*March* 20, 1952).

For Pt VII, see Abstr. 1715 (1952).

536.423.4 : 530.162

7222. The statistical mechanical theory of irreversible condensation. I. H. REISS. *J. Chem. Phys.*, **20**, 1216–26 (*Aug.*, 1952).

A theory of nucleation, based on statistical mechanics, is presented. The problem reduces to the computation of the multiple occupation, by molecules, of cells, this being accomplished through the evaluation of the configuration integral for a supersaturated assembly. The new theory does not consider the first fragments of the stable phase formed to be spherical liquid drops. In no place (not even at the nucleus) is it necessary to consider explicitly phase equilibrium between an embryo and the mother phase. The manifold difficulties connected with this point (in view of the small dimensions of typical nuclei) are therefore obviated. Furthermore, it is possible to define an embryo unambiguously, and in such a manner that its energetic properties can, in principle, be computed. This is not possible in the classical theory. Certain limitations on the application of Einstein fluctuation theory to supersaturated systems are demonstrated. A.

536.423.4 : 541.123.2

7223. The influence of pressure on the equilibrium between carbon dioxide and air. T. J. WEBSTER. *Proc. Roy. Soc. A*, **214**, 61–71 (*Aug.*.7, 1952).

The equilibrium between solid CO_2 and air has been examined at pressures from atmospheric to 200 atm. and at temperatures from −110 to −196°C. At the lower temperatures and higher pressures within this range the air was condensed to the liquid state. The concentration of CO_2 in the mixed phase, particularly at high pressures and the lowest temperatures, was found to be many times greater than would be expected from Dalton's law, even when modified by Poynting's relation for the effect of the compressed gas phase. Under extreme conditions the deviation was more than a thousandfold. The behaviour of this system is shown, by general phase-rule considerations, to be consistent with that of a binary system in the neighbourhood of the critical point of the more volatile component when the second component separates as the solid phase. A.

536.46 : 535.33.03

On the validity of anomalous population temperatures in flames. *See Abstr.* 7145

536.46 : 535.33.03

On the validity of spectroscopic temperature determination. *See Abstr.* 7146

536.461

7224. Longitudinal oscillations of flames in long closed combustion chambers. U. NEUBERT. *Z. angew Phys.*, **4**, 121–6 (*No.* 4, 1952).

Schlieren spark-cine-photographs (200–500 frames/sec) were taken of flames in propane-air mixtures at atmospheric pressure, which were ignited at one end of a closed glass-sided combustion vessel 24 mm square cross-section and 108 cm long. The movement of the unburnt gas-mixture ahead of the flame-front was indicated by the change in position of small pockets of heated gas produced by means of electrically heated wires spaced along the combustion tube. To achieve greater sensitivity, the wires were coated with bone-oil; this technique permitted measurement of pre-flame gas velocities as low as 10 cm/sec. It was found that as the flame velocity oscillates, the shape of the flame front alters; when the velocity is high the flame front is convex towards the unburnt gas, but when the velocity is low, the flame front becomes re-entrant. Each oscillation is accompanied by a change in direction of the unburnt gas throughout the whole combustion chamber. The phenomenon is attributed to a periodic interaction between increasing flame surface, and the enhanced heat losses which this entails. A. SCHOFIELD

536.461

7225. On the influence of strong shock waves on the propagation of gas flames in tubes. L. EHRET, U. NEUBERT AND H. HAHNEMANN. *Z. angew. Phys.*, **4**, 126–34 (*No.* 4, 1952).

Shock waves (frequency 5 kc/s) were generated by an oscillating membrane at the closed end of a combustion tube approx. 3½ m long, in which a flame in fuel-rich propane-air mixtures was initiated at the other (usually open) end. The shape and motion of the flame and of the unburnt gas ahead of the flame were investigated by a multiple-spark Schlieren technique (preceding abstract). It was found that as the intensity of the shock waves increases, the shape of the flame front changes from its usual paraboloidal form to a plane transverse to the tube axis, the axial flame velocity decreasing until eventually the flame is extinguished. Under the influence of shock, the unburnt gas ahead of the flame moves uniformly in the same direction as the flame, at a velocity 0·25 to 0·50 times the flame speed; no uniform motion of the unburnt gas could be detected under non-shock conditions. It is suggested that the periodic reversal of the field of flow due to passage of successive shock waves, causes transfer of reacted products through the flame front, thus reducing the fuel concentration immediately ahead of the flame and hence diminishing the flame speed. A. SCHOFIELD

536.462 : 536.52

7226. Use of radiation from incandescent particles as an indication of flame temperature. E. K. PLYLER AND C. J. HUMPHREYS. *J. Res. Nat. Bur. Stand.* [*Wash.*] **47**, 456–60 (*Dec.*, 1951).

This study was undertaken to determine if the radiation from incandescent carbon particles could be utilized in the measurement of the temperature of flames. This is a preliminary investigation of the measurement of flame temperatures by using the intensities in the ultraviolet continuum at two wavelengths chosen in regions comparatively free from molecular bands and comparing these energies with the continuous emission at the same wavelengths of a calibrated tungsten ribbon lamp containing a quartz window. Fuel-rich oxyacetylene flames were used because they contain the desired incandescent particles. The ratios of intensities in the chosen spectral regions were determined photographically and photoelectrically. Interpretation of the observed ratio for a given flame, in terms of temperature has been made, and flame temperatures from 1900° to 2400°C have been determined. A.

536.48

7227. The specific heat of liquid helium between 0·25 and 1·9°K. H. C. KRAMERS, J. D. WASSCHER AND C. J. GORTER. *Physica*, **18**, 329–38 (*May*, 1952).

New measurements were made of the specific heat of liquid He, employing a capillary-connected calorimeter and using the demagnetization method with a properly chosen paramagnetic salt for reaching temperatures below 1°K. It was found that the specific heat below 0·6°K satisfies a T^3-law as was expected from theoretical predictions. Above this temperature, the measured values were compared with Landau's formula on the roton specific heat. These new values of the specific heat were used for the recalculation of the entropy of liquid He II. A.

536.48

7228. Heat conduction by the unsaturated helium II film. E. LONG AND L. MEYER. Letter in *Phys. Rev.*, **87**, 153 (*July* 1, 1952).

Describes preliminary measurements using similar apparatus to that of Bowers, Brewer and Mendelssohn [Abstr. 4314 (1952)]. In the unsaturated film, a high heat transport occurs only below a temperature identical with the "onset" temperature for film flow [Abstr. 4317 (1952)]. R. B. DINGLE

536.48

7229. On the flow of He II around a spherical obstacle. H. H. WOLDRINGH. *Physica*, **18**, 277–84 (*May*, 1952).

The flow of He II around a thermally conducting spherical obstacle is investigated theoretically on the basis of the two-fluid model, the boundary conditions at infinity being that the velocities of the normal and superfluid components may have different magnitudes, but shall lie in the same direction, while the temperature there also has a given value. The temperature, pressure and velocity fields, as well as the force exerted by the fluid on the sphere, are derived on the assumption that terms quadratic in the velocities may be neglected. A.

536.48

7230. An anomalous type of He^3 flow. E. F. HAMMEL AND A. F. SCHUCH. Letter in *Phys. Rev.*, **87**, 154–5 (*July* 1, 1952).

Below the λ-point, He^3 in dilute solution in He shows the following properties in flow through fine capillaries: (1) constant velocity of transfer independent of driving pressure, (2) independence of length of path, (3) inappreciable flow until relative

partial pressure is almost unity, (4) only slight change in flow rate as λ-temperature of solution is approached, and (5) He^3 flow independent of whether or not He^4 is flowing through the same channel. R. B. DINGLE

536.483

7231. A hydrogen liquefier using neon as an intermediate. C. B. HOOD AND E. R. GRILLY. *Rev. Sci. Instrum.*, **23**, 357–61 (*July*, 1952).

A H liquefier is described in which the H is condensed at 6·6 atm by means of liquid Ne produced in a Joule–Thomson liquefier. This cascade liquefier produced and consumed 17 litres/hour of liquid Ne and produced 27·5 litres/hour of liquid H, representing an increase of 6 to 20% over direct Joule–Thomson liquefaction of H. Means are described whereby further increase in yield and ease of operation could be achieved. Owing to some mechanical difficulties, the elimination of which would mean major construction changes, the system was abandoned in favour of the original Joule–Thomson method. A.

536.483 : 532.51

7232. On the theory of the Ranque–Hilsch cooling effect. J. J. VAN DEEMTER. *Appl. Sci. Res. A*, **3**, 174–96 (*No.* 3, 1952).

An extended Bernoulli equation, adapted to turbulent flow, is applied to a model of the rotational flow in the Ranque–Hilsch vortex tube. It is shown that on the basis of this model a reasonable quantitative explanation of the cooling effect can be given. The experimental results of Hilsch and of Elser and Hoch agree for the greater part with this theory. As to the construction of the apparatus, a theoretical interpretation is given of the influence of the size of the diaphragm. A.

536.511 : 536.48

7233. A new type of gas thermometer and a determination of the boiling point of hydrogen. A. S. BOROVIK-ROMANOV AND P. G. STRELKOV. *Dokl. Akad. Nauk SSSR*, **83**, 59–61 (*No.* 1, 1952) *In Russian.*

The thermometer comprises a copper vessel divided into two compartments by a membrane; each compartment contains helium. The upper compartment is sealed and is the bulb of the thermometer while gas can be admitted into the lower compartment so that the pressure is the same in both sides of the membrane. The pressure in the lower compartment is read on a manometer and departures from equality are detected by using the membrane as one plate of a parallel-plate condenser. Using the heterodyne beat method departures of less than 0·01 mm of Hg can be detected. The thermometer is standardized by assuming the boiling point of oxygen to be 90·19°K and is filled to a pressure of 850 mm at this temperature. The boiling point of ordinary hydrogen (75% para) was obtained by making allowance for the expansion of the bulb and using the second virial coefficients of helium at the boiling points of hydrogen and oxygen. The final value obtained is 20·380 ± 0·0022°K. J. M. HOUGH

536.532

7234. Thermal measurements on small transient systems. R. A. W. HILL. Letter in *Nature* [*Lond.*] **170**, 29–30 (*July* 5, 1952).

It has been found possible to heat the wires of a thermocouple by the passage of a current and at the same time to record the temp. of the junction by its thermo-e.m.f., the concomitant voltage being separated from the thermo-e.m.f. by using h.f. current and inductance-capacitance filters. The thermal constants of poor conductors can be measured. Apparatus as small as 1 cm long by 0·1 cm dia. can be used, and the speed of measurement, ~100 msec, enables measurements at high temps and under transient conditions to be made. W. C. MOSS

536.587 : 621.365.3/.4 : 621.316.7

7235. A simple furnace temperature controller. M. SHEPHERDSON. *J. Sci. Instrum.*, **29**, 263–4 (*Aug.*, 1952).

A two-position controller is described for use with a thermocouple or d.c. resistance bridge as sensing element. The error signal operates a mirror galvanometer which controls the position of a spot of light on a photocell. This, through a single valve amplifier, controls a thermal relay which switches the power. The circuit is very simple and is arranged to prevent overheating of the furnace whatever probable fault develops. A.

536.628

7236. An impulse method for determination of specific heat. V. I. KHOTKEVICH AND N. N. BAGROV. *Dokl. Akad. Nauk SSSR*, **81**, 1055–7 (*No.* 6, 1951) *In Russian.*

Metallic specimens in the form of thin wires (dia. 0·08–0·30 mm, length 15–50 mm) were heated electrically for periods of 10–15 msec; the current through the wire and the voltage drop along it were recorded on a c.r. oscillograph. From this data, the energy supplied to the specimen and also (knowing the temp. coeff. of resistivity) its temp. rise can be calculated; hence the specific heat can be deduced. During such short periods of heating, thermal losses may be shown not to exceed 3%. This method has been applied to measurement of the specific heats of Cu, W, Mo and Cd, and the results have been found to agree to better than 3% with those obtained by more elaborate methods. It is claimed that this method is simple, rapid and reasonably accurate, and can be applied up to 800°C, both for direct measurement of specific heats and for detecting phase changes in heated alloy. A. SCHOFIELD

536.631

7237. Results of low temperature research. IX. The atomic heat of cobalt between 15° and 270°K. K. CLUSIUS AND L. SCHACHINGER. *Z. Naturforsch.*, **7a**, 185–90 (*Feb.*, 1952) *In German.*

For Pt VII, see Abstr. 3131 (1950).

536.631

7238. The heat capacity and entropy of gold from 15 to 300°K. T. H. GEBALLE AND W. F. GIAUQUE. *J. Amer. Chem. Soc.*, **74**, 2368–9 (*May* 5, 1952).

The heat capacity of single crystal gold has been measured from 15 to 300°K. The heat capacity at constant volume has been calculated and compared with the Debye equation, which is used only as an idealized reference curve. The results, compared with those on several other face-centred cubic metal crystals, show that the distribution of vibrational frequencies is characteristic of each metal. This is

in agreement with the theoretical expectations of Blackman. The entropy, heat content and free energy have been tabulated. The entropy, less nuclear spin and isotope effects, was found to be $11{\cdot}32 \pm 0{\cdot}02$ cal. deg.$^{-1}$ mole^{-1} at 298·16°K. A.

536.632

7239. Heat capacity of potassium and three potassium–sodium alloys between 0° and 800°, the triple point and heat of fusion of potassium. T. B. Douglas, A. F. Ball, D. C. Ginnings and W. D. Davis. *J. Amer. Chem. Soc.*, **74**, 2472–8 (*May* 20, 1952).

Measurements were made of the changes in enthalpy of potassium and three potassium–sodium alloys (containing approximately 45, 54 and 78% of potassium) over the range 0 to 800°, using an ice calorimeter as earlier with sodium [Abstr. 1962 (1950)]. From the enthalpy values were derived the heat capacities, as well as the heat of fusion and relative entropy of potassium. The heat capacities of the liquid alloys were found to correspond closely at each temperature between 100 and 800° to those calculated additively from the authors' values for pure liquid potassium and sodium. As with sodium, each liquid shows a minimum in heat capacity between 500 and 650°. The melting curve and triple point of potassium also were determined. A.

536.632

7240. Measuring specific heat of liquids at high temperatures. N. H. Spear. *Analyt. Chem.*, **24**, 938–41 (*June*, 1952).

A small-sample calorimeter using twin radiation tubes was developed to measure accurately at high temperatures specific heats of new heat-transfer liquids under development. The calorimeter is readily calibrated, has a temperature range to over 300°C, and measures with an accuracy better than 5% on samples of approximately 35 ml. Specific heat for one liquid is reported and data are compared with data on another liquid which was available for measurement by conventional methods. A.

536.633

7241. Heat capacity of gaseous carbon dioxide. J. F. Masi and B. Petkof. *J. Res. Nat. Bur. Stand.* [*Wash.*] **48**, 179–87 (*March*, 1952).

The heat capacity (C_p) of gaseous carbon dioxide has been measured at −30°, 0°, +50° and +90°C and at 0·5, 1·0 and 1·5 atmosphere pressure, with an accuracy of 0·1%. The flow calorimeter used was a modification of one previously described [Abstr. 1488 (1945)]. In order to test the accuracy of the calorimeter, the heat capacity of oxygen was measured at 1 atmosphere at −30°, 0°, and +50°C. The measured values of C_p for oxygen were combined with an equation of state to give C_p°; these differed from the statistically calculated values by +0·03, −0·06 and −0·01% at the three temperatures. The experimental values of C_p for carbon dioxide have been used to calculate new values of C_p° and values of the pressure coefficient of heat capacity at the four temperatures of measurement. Theoretical values of C_p calculated in 1949 were found to be too low by 0·2 to 0·3%; the results of a new calculation are in substantial agreement with the experiments. The pressure coefficients are in agreement with those obtained from recent work [Abstr. 127 (1951)]. A.

536.69

7242. Heats of formation of quartz and cristobalite. G. L. Humphrey and E. G. King. *J. Amer. Chem. Soc.*, **74**, 2041–2 (*April* 20, 1952).

A combination of combustion and solution calorimetry was used to obtain the heats of formation of low-quartz and low-cristobalite from the elements. The results are $\Delta H_{298\cdot16} = 210\,260 \pm 270$ and $\Delta H_{298\cdot16} = -209\,330 \pm 250$ cal./mole. A.

THERMODYNAMICS 536.7/.8

536.7

7243. Thermodynamic properties of nitrogen as functions of pressure and temperature between 0 and 6000 atmospheres and −125° and +150°C. R. J. Lunbeck, A. Michels and G. J. Wolkers. *Appl. Sci. Res. A*, **3**, 197–210 (*No.* 3, 1952).

536.7 : 530.145 : 530.162

7244. Thermodynamic continuity and quantum principles. A. Landé. *Phys. Rev.*, **87**, 267–71 (*July* 15, 1952).

A condensed survey is given of the results of a previous investigation on quantum concepts and principles developed from the anti-Gibbs postulate of thermodynamic continuity. The same postulate now also yields major parts of quantum statistics, such as the equality of various occupation number sets without permutation of individual particles, not however the alternative "either Bose or Fermi statistics." A distinction must be made between a coherent redistribution of particles without entropy change, and an incoherent redistribution leading to a new thermodynamic equilibrium. The latter is obtained from the former by a process of diffusion from separate level groups to a totality of levels. A.

536.7 : 530.145

On the thermodynamics of wave fields. *See Abstr.* 7026

536.7 : 532.7 : 539.21

7245. Mixtures. (The theory of the equilibrium properties of some simple classes of mixtures, solutions and alloys). E. A. Guggenheim. *Oxford, The Clarendon Press* (1952) 270 *pp.*

This book gives a thorough treatment of the thermodynamics of mixtures of solids, gases and liquids, the assumption of a quasi-crystalline structure for the latter being a very pertinent one in the light of modern experimental work. Though a preliminary reading of the author's "Thermodynamics" is a decided advantage, the excellent introductions to classical and statistical thermodynamics given in the first two chapters render this a luxury rather than a necessity. It is difficult to lay emphasis on one part more than another, but it should be noted that the chapter on regular solutions and also that on superlattices is exhaustive to say the least, in the latter chapter the systems CuZn and $AuCu_3$ being discussed in considerable detail. Throughout, the mathematics is maintained as simple as possible and there is

requent comparison with experimental results. The book is well illustrated with graphs and tables and also ontains a considerable number of references.

T. C. TOYE

536.71 : 530.162

7246. Statistical theory of equations of state and phase transitions. I. Theory of condensation. C. N. YANG AND T. D. LEE. *Phys. Rev.*, **87**, 404–9 (*Aug.* 1, 952).

A theory of equations of state and phase transitions s developed that describes the condensed as well as he gas phases and the transition regions. The hermodynamic properties of an infinite sample are tudied rigorously and Mayer's theory is re-examined.

A.

536.71 : 530.162

7247. Statistical theory of equations of state and phase transitions. II. Lattice gas and Ising model. T. D. LEE AND C. N. YANG. *Phys. Rev.*, **87**, 410–18 (*Aug.* 1, 1952).

The problems of an Ising model in a magnetic field nd a lattice gas are proved mathematically equivalent. From this equivalence an example of a two-dimensional lattice gas is given for which the phase transition egions in the $p - v$ diagram is exactly calculated. A theorem is proved which states that under a class of general conditions the roots of the grand partition function always lie on a circle. Consequences of this theorem and its relation with practical approximation methods are discussed. All the known exact results about the two-dimensional square Ising lattice are summarized, and some new results are quoted. A.

536.75

7248. The entropy of fluorine. G. M. MURPHY AND E. RUBIN. Letter in *J. Chem. Phys.*, **20**, 1179–80 (*July*, 1952).

The recalculation of entropy data gives an unexplained discrepancy of 3·322 eu/mole between the experimental and calculated value of the standard entropy of F, which, the authors believe, suggests a missed transition in the solid phase. F. LACHMAN

536.75

7249. The role of the increase of entropy in the analysis of thermal processes. D. P. GOKHSHTEĬN. *Zh. Tekh. Fiz.*, **21**, 1121–36 (*No.* 9, 1951) *In Russian.*

A method is developed of using the increase of entropy in an isolated system for analysing the completeness of thermal processes. It is shown that the degree of deviation of real processes from the ideal ones is more distinctly and objectively characterized by the ability of heat to do work and by the degradation of energy in an isolated system than by the idea of efficiency. The degradation of energy in an isolated system is strictly defined as the product of the increment of its entropy by the absolute temperature of the ambient medium. Owing to the additive nature of entropy, an equation characterizing the degree of perfection of the heat diagram and of the working process of a plant can be developed as a function of the sum of variables; this equation lends itself better to mathematical transformations than that of efficiency, which is a function of a product of variables.

F. LACHMAN

ELECTRICITY 537

ELECTROSTATICS . DIELECTRICS 537.2

537.221 : 551.594

7250. Production of electric charges on water drops. E. J. WORKMAN AND S. E. REYNOLDS; E. W. B. GILL. Letters in *Nature* [*Lond.*] **169**, 1108–9 (*June* 28, 1952).

The implication is refuted which is implied in a recent communication [Abstr. 3563 (1952)] that the potential differences accompanying the freezing of dilute aqueous solutions be interpreted as contact potentials. The effect of impurities on the sign of the resulting potential differences and the mechanism of charge separation during the freezing process are discussed. R. H. GOLDE

537.226

7251. Random noise in dielectrics. H. BAUSS AND R. F. BOYER. Letter in *J. Appl. Phys.*, **23**, 802–3 (*July*, 1952).

It is shown that the noise generated when a potential is applied across a thin layer of certain polymers disappears when the temperature is reduced below the second-order transition temperature. The authors consider that this confirms their hypothesis that the noise is due to ionic diffusion controlled by the jump frequency of the polymer segments. A. H. W. BECK

537.226.1

7252. On the correlation between the dielectric strength and the mobility of charge in a dielectric. E. K. ZAVADOVSKAYA. *Dokl. Akad. Nauk SSSR*, **82**, 565–6 (*No.* 4, 1952) *In Russian.*

A short theoretical discussion of breakdown in dielectrics, by considering the way an applied field favours the motion of electrons or holes in one direction. It is shown that the mobility is approximately inversely proportional to the applied field in agreement with previous results on Ge. On classical mechanics it is shown that the dielectric strength is inversely proportional to the lattice spacing.

J. M. HOUGH

537.226.2/.3

7253. The dielectric constant and loss of amorphous selenium at a wavelength of 3 cm. H. A. GEBBIE AND D. G. KIELY. Letter in *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 553 (*July*, 1952).

The dielectric constant, $5{\cdot}97 \pm 0{\cdot}04$ of Se at $1{\cdot}024 \times 10^{10}$ c/s and 18°c agrees with the infrared value, but is lower than the static value indicating a dispersion region below 10^{10} c/s. D. H. WHIFFEN

537.226.2

7254. Dielectric properties of several halides of hydrogen and deuterium in the solid state. C. S. E. PHILLIPS. *J. Phys. Radium*, **13**, 216–23 (*April*, 1952) *In French.*

The electrical dispersion, dielectric constant and loss factor of solid HCl, DCl, HI and DI have been measured as functions of frequency (80 c/s to 6 Mc/s) and temperature (63°K to the melting-point). For HCl and DCl a first-order transformation occurs at about 100°K. Above this point there are two regions of dispersion one at low frequencies with no d.c.

component, the other at much higher critical frequency (1 Mc/s for HCl at 83°K, 1·2 Mc/s for DCl at 88°K), which increases with temperature. At the transition point the low frequency loss is almost entirely suppressed and the corresponding dispersion disappears. In the second region the loss is highest at the transition temperature. Above the transition temperature the low frequency phenomena reappear, accompanied by d.c. conduction probably due to traces of impurity. No ferro-electric effects are observed. For HI and DI two second-order transitions are observed, but the critical frequencies are much higher. C. A. HOGARTH

537.226.2

7255. Dielectric constants of monocrystal hydrates: $BeSO_4 . 4H_2O$ and $MnCl_2 . 4H_2O$. A. GALY. *C.R. Acad. Sci.* [*Paris*] **234**, 2274–6 (*June* 4, 1952) *In French.*

The variation of the dielectric constants with temp. in the range 100–400°K has been studied.

G. I. W. LLEWELYN

537.226.2

7256. Ferroelectricity in the ilmenite structure. H. C. SCHWEINLER. *Phys. Rev.*, **87**, 5–11 (*July* 1, 1952).

The ferroelectricity of the ilmenite structure minerals Li tantalate and Li niobate is studied theoretically, using the method recently introduced by Slater for Ba titanate. The metal ions are assumed to move in a potential which has small quartic terms as well as the usual quadratic terms, all satisfying the appropriate crystal symmetry requirements. This results in a slight dependence of the ionic-displacement polarizability of each metal ion on both the temperature and the polarization of the crystal. The local electric field strength is computed exactly for each ion by Ewald's method, and the internal field constants are given for a number of positions in a rhombohedral unit cell of axial angle $\alpha = 56°$. The polarizabilities can be estimated from other crystal polarization data, leading to a spontaneous polarization below the upper Curie temperature T_0 of $2(T_0 - T)^{\frac{1}{2}}$ microcoulombs cm^{-2} (without electromechanical correction). Whereas in Ba titanate all dipole moments are in the direction of the resultant polarization, it is found here that the lower crystal symmetry results in sizeable components of the oxygen dipole moments perpendicular to the total polarization, but these last components produce a large field in the direction of the polarization at other ionic positions. A.

537.226.2

7257. On the dielectric constant of Rochelle salt at 3000 Mc/sec. H. AKAO, T. TAKAKURA AND T. SASAKI. *J. Phys. Soc. Japan*, **7**, 361–3 (*July–Aug.*, 1952).

The dielectric constant of Rochelle salt was measured at 3000 Mc/s using a new method in which the dielectric constant is obtained by measuring Q of a rectangular H_{101} mode cavity, one E-plane of which is closed by Rochelle salt surface. The dielectric constant at this frequency is smaller than that at lower frequencies, though it shows two peaks at the Curie points. A.

537.226.2

7258. Dielectric properties of ice and solid D_2O. R. P. AUTY AND R. H. COLE. *J. Chem. Phys.*, **20**, 1309–14 (*Aug.*, 1952).

Complex dielectric constants have been measured for ice from the melting point to − 65°C, and for solid D_2O to − 35°C, by a combination of bridge and transient methods. For both, the dispersion is described by the simple Debye formula, and the relaxation times τ by the simple rate expression $\tau = A \exp(B/RT)$. For ice, $A = 5{\cdot}3 \times 10^{-16}$ sec, $B = 13{\cdot}2$ kcal/mole; and for solid D_2O, $A = 7{\cdot}7 \times 10^{-16}$ sec, $B = 13{\cdot}4$ kcal/mole. The equilibrium dielectric constant for ice is 91·5 at 0°C and increases at lower temperatures; the values for solid D_2O are only slightly smaller. Measures taken to minimize errors from voids in the sample and direct current conductance are discussed. A.

537.226.2

7259. A calculation of the static dielectric constant of ice. J. G. POWLES. *J. Chem. Phys.*, **20**, 1302–8 (*Aug.*, 1952).

A calculation is made of the static dielectric constant of ice using only simple molecular data and with well-defined assumptions as to the possibilities of molecular movement in the crystal. The paper serves as an illustration of the procedure for calculating static dielectric constants, and it results in a numerical value of this quantity for ice which is in reasonable agreement with experiment. A.

537.226.2 : 621.3.011.5

7260. On the theory of the dielectric constants of mixtures. G. ECKART. *Z. angew. Phys.*, **4**, 134–6 (*No.* 4, 1952) *In German.*

It is shown that if in a medium of permittivity ε_2 there are immersed n spheres of radius a and permittivity ε_1 per unit volume, the resultant permittivity is $\varepsilon_{res} = \varepsilon_2[1 + \sigma/(1 - \sigma/3)]$, where $\sigma = \frac{4\pi n a^3}{3} \cdot \frac{3(\varepsilon_1 - \varepsilon_2)}{2\varepsilon_2 + \varepsilon_1}$. This gives the correct values at zero and 100% "mixtures." Graph sheets to assist the computation, and examples, are given. F. F. ROBERTS (R)

537.226.2 : 621.317.374 : 621.317.335.3

7261. Measurement of the electrical properties of strongly absorbing dielectrics in the centimetre-wave region by the "infinite layer" method. N. V. ALEKSANDROV. *Z. Tekh. Fiz.*, **21**, 647–51 (*No.* 6, 1951) *In Russian.*

Permittivity and loss angle are investigated theoretically and experimentally. Data on pine-wood, aniline, ethyl alcohol and its aqueous solution are recorded. The method is very useful, particularly for materials of very large absorption ($\tan \delta \geq 0{\cdot}1$). F. K. CZARNIECKI

537.226.2 : 621.392.26 : 621.317.335.3

7262. Application of a waveguide to measurement of the permittivity of materials. N. KOTOSONOV AND G. PAKHOMOV. *Z. Tekh. Fiz.*, **21**, 802–7 (*No.* 7, 1951) *In Russian.*

The method is used for liquids in the cm range and is based on observation of the Brewster angle. Experimental technique is fully described and illustrated by diagrams. Results are given for toluene, xylene and aniline. The method is very simple and

is at present used for liquids only, but could be adapted for measurement of the permittivity and power factor of solids also. Its accuracy depends strictly on the accuracy of the Brewster angle reading.
F. K. CZARNIECKI

537.226.3

7263. Dielectric loss in a polar gas near its critical point. H. G. DAVID, S. D. HAMANN AND J. F. PEARSE. Letter in *Nature* [*Lond.*] **169,** 1106 (*June* 28, 1952).

Liquid-like dielectric loss at 1 Mc/s in compressed CH_3F above the critical temperature sets in fairly sharply as the critical density is reached on increasing the pressure at both 50°C and 75°C. D. H. WHIFFEN

537.226.3

7264. Microwave absorption and molecular structure in liquids. IX. Measurement in organic halides at 10-cm wavelength. F. H. BRANIN, JR AND C. P. SMYTH. *J. Chem. Phys.*, **20,** 1121–8 (*July*, 1952).

For Pt VII, see Abstr. 4332 (1952). The results of a systematic investigation of dielectric dispersion and absorption in the microwave region are discussed. Simple relations between the complex dielectric constant of an absorptive medium and the complex propagation constant of an electromagnetic wave within the medium are discussed in connection with a new interferometric method for measuring wavelength and absorption index directly within the medium. Results of measurements made at 10-cm wavelength by this method on twenty-five liquid organic halides are reported. The data of the present and previous measurements on these compounds are discussed in terms of distributions of relaxation times and, on the basis of absolute rate theory, the processes of dipole orientation and viscous flow in these liquids are compared. A.

537.226.3

7265. Dielectric relaxation in polymeric halogenated styrenes. K. Z. FATTAKHOV. *Zh. Tekh. Fiz.*, **22,** 313–24 (*No.* 2, 1952) *In Russian.*

Contains full dielectric dispersion data for polystyrene and its *p*–F, *p*–Cl, *o*–Cl, *p*–Br, *p*–I, 2 : 5–diCl, 3 : 4–diCl derivatives from 0·1–20 kc/s. Typical is poly-orthochlorstyrene of setting temperature 94°C for which at 156·5°C $\varepsilon'_0 = 4{\cdot}7$, $\varepsilon''_{max} = 0{\cdot}570$ at 1 kc/s and the temperature coefficient of τ corresponds to an activation energy of 87 kcal/mole. Volume expansion coefficients and setting or "glassifying" temperatures are also given. D. H. WHIFFEN

537.226.3 : 621.396.611.21

7266. Thermal treatment and internal friction of piezoelectric quartz. G. FRIGERIO. *Alta Frequenza*, **21,** 102–4 (*April*, 1952) *In Italian.*

Chemical treatment of quartz crystals with HF has been found to reduce losses at the surface, thereby improving the *Q*-factor. An investigation was carried out to determine whether thermal treatment produced the same effect. Crystals were heated rapidly up to 540°C, kept at this temperature for 24 hrs, then cooled at the rate of 2°C/hr down to ambient temperature. Results were only partially successful, in one case a tripling of the *Q*-factor was achieved, in others the *Q* rose only slightly or not at all.

537.228

7267. The effect of electric field on the domain structures in Rochelle salt. M. MARUTAKE. *J. Phys. Soc. Japan*, **7,** 25–9 (*Jan.–Feb.*, 1952).

The domain structures in the Rochelle salt crystal were observed in polarized light under varied electric field. It was found that the motion of the domain boundaries shows hysteresis and relaxation phenomena, and sometimes Barkhausen effect. It was also found that the domain does not always penetrate the crystal and some domains are supposed to be wedge-shaped in the direction of thickness (along the *a*-axis). A.

537.228.1 : 621.3.012.3 : 621.396.611.21

7268. Use of nomogram for determining characteristics of quartz crystal. J. COULON. *C.R. Acad. Sci.* [*Paris*] **234,** 1965–8 (*May* 12, 1952) *In French.*

A method is described for constructing a nomogram to evaluate the equivalent circuit constants. See also Abstr. 4345, 5773 (1952). H. J. H. STARKS

537.228.2

7269. Electrostrictive effects in ferroelectric ceramics. G. A. SMOLENSKIĬ. *Zh. Tekh. Fiz.*, **21,** 1045–9 (*No.* 9, 1951) *In Russian.*

Temperature relationship of the coefficient of linear expansion of polycrystalline samples of $BaTiO_3$, $PbTiO_3$ and $PbZrO_3$ was investigated. It was found that the titanates of lead and barium have positive volumetric spontaneous electrostriction and the $PbZrO_3$ negative. In ferroelectrics occurs an anomaly of the coefficient of thermal expansion, near the Curie point, due to the electrostrictive effect. Ferroelectrics with zero electrostriction should have high value of dielectric permeability. Low temperature phase change in $PbTiO_3$ was found near −30°C. In $PbZrO_3$ it was not observed in temperatures down to −160°C. J. LUKASZEWICZ

ELECTRIC CONDUCTION . CURRENTS 537.3

537.3 : 621.38

7270. Voltage bursts of fluctuation noise. V. I. BUNIMOVICH. *Zh. Tekh. Fiz.*, **21,** 625–36 (*No.* 6, 1951) *In Russian.*

The problem of frequency and characteristics of voltage bursts of random noise which exceed a given amplitude is investigated mathematically. It is assumed that the fluctuation process is stationary and that the probability distribution follows the Gaussian law. Formulae are derived for the envelope of the amplitude distribution density, mean duration of bursts, their mean frequency and the r.m.s. frequency. A numerical example, pertaining to a valve amplifier with a resonant and with a RC load is calculated.
A. LANDMAN

537.3 : 621.38

7271. Observed groupings of electrical fluctuation bursts. V. I. BUNIMOVICH. *Zh. Tekh. Fiz.*, **21,** 637–46 (*No.* 6, 1951) *In Russian.*

Referring to the theoretical investigations of the author and work undertaken by Pumper [*Dokl.*

Akad. Nauk SSSR, **53**, 25 (1946)] a mathematical analysis of probable occurrences and characteristics of fluctuation noise bursts after passage through a narrow band filter is presented and checked by oscillographic observation, the pre-supposition being that the envelope of the probability distribution follows a sinusoidal law. Formulae are derived for the mean number of bursts, the mean number of burst groups and their mean duration. The results obtained agree with the more general formulae derived by the author (see preceding abstract) by a different approach. A. LANDMAN

537.3 : 621.38

7272. The characteristics of noise currents and voltages. H. BITTEL. *Z. angew. Phys.*, **4**, 137–46 (*No.* 4, 1952) *In German.*

Discusses the distribution in amplitude of the noise, which is usually but not invariably Gaussian. The reasons for departures from the Gaussian form are discussed. Experimental proof of the distribution for resistance and valve noise is given and the performance of rectifiers discussed. A. H. W. BECK

537.311.3

7273. Problem of the behaviour of electrons in ionic crystals. F. F. VOLKENSHTEĬN. *Zh. Eksper. Teor. Fiz.*, **22**, 184–93 (*No.* 2, 1952) *In Russian.*

Discusses the same problem as that treated in a previous paper [Abstr. 6957 (1951)], but a solution is attempted for the case when a cyclic condition is assumed to be superimposed on an infinite unidimensional lattice. The behaviour of two "spare" electrons in the crystal lattice is treated as a many-electron problem, i.e. beyond the zone theory. Two different types of states are obtained: "single-electron" states corresponding to the zone theory (independent electrons), and "doublon" (double-electron) states when both electrons are rigidly connected and move in the lattice as a whole. The cyclic condition being taken into account, the numbers of the single-electron and double-electron states are evaluated, yielding the correct total number of states. The conditions required for the appearance of the double-electron type states are defined. F. LACHMAN

537.311.3 : 539.234

7274. Measurement of the resistance of thin insulating films between gold contacts in the range of the tunnel effect. I. DIETRICH. *Z. Phys.*, **132**, 231–8 (*No.* 2, 1952) *In German.*

A method is described for measuring the resistance of thin films evaporated on to metal surfaces. The film thickness is measured by interferometry and the relation between thickness and resistance is given for TiO_2 and Au. Up to a thickness of about 100 Å this is accounted for by the tunnel effect.

M. R. HOPKINS

537.311.31

7275. A note on the theory of conduction in metals. E. H. SONDHEIMER. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 561–2 (*July*, 1952).

It is pointed out that in any collision involving a quasi-free electron with wave vector k and a lattice wave q the conservation conditions are $|k| = |k + q|$ so that an electron in a state k can only interact with lattice waves for which $|q| \leqslant 2|k|$. The consequences of this result on various aspects of the theory of metals are considered. C. A. HOGARTH

537.311.31

7276. The electrical resistance of binary metallic mixtures. R. LANDAUER. *J. Appl. Phys.*, **23**, 779–84 (*July*, 1952).

The existing theories of the resistivity of mixtures assume regular arrangements of the two components, rather than random mixtures. A theory for a random mixture is given, based on the assumption that each crystal acts as if surrounded by a homogeneous medium whose properties are those of the mixture. Comparisons with experiment are made. The experimental data that have been examined fall roughly into two classes. One class consists of mixtures, where the variation of resistivity with composition disagrees violently with this theory, making it clear that the assumptions made are completely inapplicable. The remaining class consists of mixtures which generally agree well with the theory. A.

537.311.31

7277. On a theory of the electric conductivity of ordered binary metallic alloys. K. B. VLASOV. Letter in *Zh. Eksper. Teor. Fiz.*, **22**, 251–4 (*No.* 2, 1952) *In Russian.*

The resistance is analysed into 3 terms arising from the scattering of electrons on (1) the lattice inhomogeneities, (2) scattering on phonons and (3) a term due to the effect of the ordering of the atoms on the energy spectrum of the conduction electrons. The deduced temperature dependence is illustrated by existing data on the resistance of Cu–Au and Cu–Pd alloys at 0° and −195°C. W. J. SWIATECKI

537.311.31 : 536.21

An investigation of the validity of the Wiedemann–Franz–Lorenz law. *See Abstr.* 7216

537.311.31 : 536.48

7278. On the resistance minimum of magnesium at low temperatures. L. S. KAN AND B. G. LAZAREV. *Dokl. Akad. Nauk SSSR*, **81**, 1027–9 (*No.* 6, 1951) *In Russian.*

It was found that the presence of a minimum in the resistance-temperature curve of magnesium [Abstr. 4376 (1951)] was very sensitive to the method of attaching current and potential leads and to purity. For 2 polycrystalline specimens in which the soldered connections formed part of the measured resistance a pronounced minimum at 3·3°K in one specimen and 3·8°K in the other was observed, but with a second mounting in which end contamination was avoided no minimum was observed (the ratio R/R_0 of the resistance at 4·2°K to that at room temperature was $4{\cdot}57\times10^{-3}$). For an annealed polycrystalline specimen with $R/R_0 = 2{\cdot}57\times10^{-3}$ mounted in the second way no minimum was observed either. D. SHOENBERG

537.311.31

7279. On the theory of internal field emission. J. HOMILIUS. Note in *Z. Naturforsch.*, **7a**, 290– (*March–April*, 1952) *In German.*

This note is concerned with the probability of an electron making a transition from a full band across an energy gap into the next empty band. It is stated that: (1) contrary to a remark by Houston (1940), th

atter's method of treating the 3-dimensional problem s in agreement with Zener's one-dimensional theory 1934), and (2) the effect should depend markedly on irection in face-centred cubic lattices. It is inferred hat this effect cannot be responsible for the electrical reakdown of alkali halide crystals, which appears to e independent of direction. P. T. LANDSBERG

537.311.32

7280. Dependence of the electrical conductivity of quartz on the electric field, temperature and magnetic field. P. E. SARZHEVSKIĬ. *Dokl. Akad. Nauk, SSSR*, **82**, 571–4 (*No.* 4, 1952) *In Russian.*

For small electric fields quartz obeys Ohm's law but for large fields the conductivity σ is given by $\sigma = \sigma_0 e^{-B_1/T} + \sigma_2 e^{-B_2/T}$, where σ_1 and σ_2 are constants for a particular sample of quartz, $B_2 = 21\,000°\text{K}$ and $B_1 = B_0 - \beta T\sqrt{E}$ where E is the applied field in volts/cm and β and B_0 are constants depending on crystallographic orientation. For fields parallel to the axis $B_0 \simeq 12\,000°\text{K}$ and $\beta \simeq 0{\cdot}01$ (cm/volt)$^{\frac{1}{2}}$ and for perpendicular fields $B_0 = 14\,000°\text{K}$ and $\beta \simeq 0{\cdot}001$ (cm/volt)$^{\frac{1}{2}}$. For a constant electric field, the change in resistance $\Delta\rho$ for the field valve ρ_0 is given by $\Delta\rho/\rho_0 = CH^2$ where H is the magnetic field in oersteds and $C = 10^{-11} - 10^{-10}$ oersteds^{-2}. Comparison with theory gives values for the mobility of electrons in quartz of the order of 100 cm^2 volt^{-1} sec^{-1} and the number of free electrons per cm^3 as 10–10^5.

J. M. HOUGH

537.311.32 : 536.21

Thermal and electrical conductivities of carbon materials. *See Abstr.* 7217

537.311.33

7281. Some electrical properties of silicon carbide. L. I. IVANOV, V. I. PRUZHININA-GRANOVSKAYA AND I. V. CHERNINA. *Zh. Tekh. Fiz.*, **21**, 1050–60 (*No.* 9, 1951) *In Russian.*

An investigation of electric conductivities of blocking layers and of mass of SiC was carried out on powders of SiC. Non-linearities of voltampere characteristics and breakdown voltages of blocking layers in silicon carbides substantially differed in resistances. There is no proportionality beween resistances of blocking layers and of the SiC mass. Each grade of carborundum can be described by a curve of relationship of coefficient of non-linearity and resistance. Resistance of powder in the non-linear range is determined by the resistance of the blocking layer. The magnitude of the coefficient of non-linearity depends on concentration of current carriers. The curve of distribution of breakdown voltage of each powder has a sharply defined maximum, the position of which is displaced towards higher voltages with the increase of the resistance of the blocking layer. J. LUKASZEWICZ

537.311.33

7282. Influence of the surface levels on the optical properties of a semiconductor or of a dielectric. G. E. PIKUS. *Zh. Eksper. Teor. Fiz.*, **22**, 331–8 (*No.* 3, 1952) *In Russian.*

A. A. Sokolov [*Zh. Eksper. Teor. Fiz.*, **6**, 807 (1936)] has shown that the absorption spectrum of a crystal must contain lines which are due to transitions of electrons from inner zones to the surface zone or possibly to the exit energy level. Unlike the lines of volume absorption, the intensity of these lines is independent of the thickness of the surface layer. The author bases his analysis on the formula for the surface conductivity $\lambda = \chi n$, where $n = (\varepsilon kT/2\pi e^2)[n_d(\mathscr{E}_d - \mathscr{E}_1)]^{1/2}$ is the electron concentration and $\chi \equiv (e^2/m)(g + i\omega)/(g^2 + \omega^2)$. Here ε, k and T are the dielectric constant, Boltzmann constant, and abs. temp. resp.; n_d is the electron concentration in the "donor" layer; $\mathscr{E}_d$ and $\mathscr{E}_1$ the energy level in the donor layer and the "acceptor" layer (or at the exit), resp.; g is the mean number of impacts of an electron per unit time in the surface zone; ω is the angular frequency of the applied e.m. field (e.g. e.m. waves). The estimated thickness of the surface zone is only about 3 Å and therefore in relation to the waves of the visible or infrared range the phenomena therein can still be regarded as surface phenomena, and the consideration of the reflection of these waves from an insulator or a semi-conductor can be based upon this formula. Further analysis follows the usual treatment of the problem of the reflection of plane e.m. waves, on the basis of Maxwell's equations, and with the use of vector analysis, and also with the simplifications arising from the requirement that the tangential component of the sum of the electric vectors of the incident, reflected and refracted, waves must be zero. The final formulae are obtained after substituting the above expression for the surface conductivity. On the basis of these results the influence of the transparency, of the true absorption, and of the metal reflection is considered upon the reflection coefficient at different angles and for different wavelengths. It is pointed out that the influence of the energy levels in the surface zone can be detected only through the transparency, preferably by using two media with equal refraction indices. A graph is given, drawn from the calculations, of the reflection coefficients, as determined by the transparency, the true absorption, and the metal reflection, separately, as a function of the angle of reflection. It follows from this graph that in order to test the calculations experimentally, the visible or infrared range should be used. A hope is expressed that it might be possible to determine from these experiments the degree of "filling" the surface zone by the electrons, and then, perhaps, to find an explanation of the surface properties of Si on the lines indicated by the author in his previous paper [Abstr. 5783 (1952)].

N. S. JAPOLSKY

537.311.33

7283. The non-uniform natures of the selenium rectifier. M. TOMURA AND Y. ABIKO. *J. Phys. Soc. Japan*, **7**, 167–70 (*March–April*, 1952).

Non-uniform natures of Se rectifiers are studied by comparing the rectification characteristics of several small rectifier elements which are cut out of a conventional mother element of normal size. Non-uniformities of various kinds of characteristics, such as spreading resistance, contact potential, experimental value of e/kT and maximum back voltage, etc., are observed with each element. They depend especially on the dimensions of the elements. The distribution of contact potential is found to be different from that of local thin patches in the barrier

layer. The contact potential distributes itself continuously at least within the area compared with the dimensions of our elements, namely 0·1 mm². But the local thin patches exist here and the mean distance between them is estimated as the order of several mm. Elements which have no local thin patches where currents due to tunnel effect flow show very high back voltages such as above 100 V. A.

537.311.33

7284. Electrical dispersion of selenium rectifier at high frequency. J. YAMAGUCHI, T. MIYAUCHI AND H. MORI. *J. Phys. Soc. Japan*, **7**, 171–3 (*March–April*, 1952).

Measuring capacitance and conductance of the Se rectifier by means of the reactance variation method, the electrical dispersion was found at about 1 Mc/s. This problem is approximately interpreted with the relaxation theory, which Lawson treated for the metal rectifier. Applying the results of measurement to the equations derived by Lawson, the value of ΔE is nearly 0·05 eV and B_0 (ionization probability B is expressed as $B_0 \exp - \Delta E/kT$) may be estimated at about 3×10^7 sec^{-1}. A.

537.311.33

7285. Rectification with tellurium contacts. J. LAGRENAUDIE. Letter in *J. Phys. Radium*, **13**, 308 (*May*, 1952) *In French*.

Rectification with Te depends largely on the contact material. Alkali and alkaline earth metals (presumably covered by a thin oxide layer) rectify reasonably well but the heavy and noble metals yield ohmic contacts. Voltages up to 100 V in the reverse direction may be maintained in some cases. Frequently the barrier height is found to be as high as 1 eV—considerably higher than the forbidden band width of Te. C. A. HOGARTH

537.311.33

7286. Rectification effects with the disulphides of molybdenum and tungsten. J. LAGRENAUDIE. Letter in *J. Phys. Radium*, **13**, 311–12 (*May*, 1952) *In French*.

It is found that both *n*- and *p*-type MoS_2 crystals can act as point-contact rectifiers. The same results are obtained with whisker materials of many kinds. Electroforming only succeeds in reducing the rectification. WS_2 only acts as a crystal diode if *p*-type and the rectification effects are less marked with whiskers of metals with high work functions. As a photo-conductor WS_2 is insensitive to visible radiation but responds beyond 1·2 μ. C. A. HOGARTH

537.311.33 : 537.312.5

7287. The influence of mercury vapour on selenium rectifiers and selenium photoelements. P. SELÉNYI. Letter in *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 552 (*July*, 1952).

The well-known effects of reducing the rectification and photosensitivity of Se cells caused by mercury vapour are discussed, and found to be in agreement with theories due to Schottky. C. A. HOGARTH

537.311.33 : 621.314.63

7288. Rectifying properties of lead sulphide. I. I. ADRIANOVA AND I. L. SOKOLSKAYA. *Z. Tekh. Fiz.*, **21**, 713–14 (*No.* 6, 1951) *In Russian*.

Measurement of the variation of the PbS rectifier current in the 1–1·5 V range *in vacuo* are described. Geisman's work on the effects of various vapours is discussed. The experiments show that rectification and contact resistance *in vacuo* decrease and there are anomalous variations in rectification direction in disagreement with theory; but disappearance of dielectric effects was not observed. F. K. CZARNIECKI

537.312.5

7289. External photoelectric emission of barium oxide. K. NOGA AND S. KAWAMURA. *J. Phys. Soc. Japan*, **7**, 287–91 (*May–June*, 1952).

The spectral distribution of photoelectric yield and its temperature dependency were measured on the BaO, in the form of a sprayed coating on a Ni base. When sample was held at room temperature, the photoelectric emission showed an enhanced effect, that is, the photo-current from the irradiated sample increased with time. The photon energy giving the maximum enhanced effect lies at 2·3 eV, coincident with the peak of optical absorption by colour centres in BaO. This enhanced effect disappeared on warming the sample to 400°K. The results are discussed in terms of an energy level structure of BaO. A.

537.312.5

7290. Afterpulsing in photomultipliers. D. W. MUELLER, G. BEST, J. JACKSON AND J. SINGLETARY. *Nucleonics*, **10**, 53–5 (*June*, 1952).

Liquid scintillators and a rotating mirror device were used as light sources to examine afterpulsing in type 5819 photomultipliers. Spurious pulses were observed to follow immediately after the main peak and in a later component following in a time of the order of 1 μsec. An experimental tube with silver–magnesium dynodes showed no afterpulsing but had a low sensitivity. A multiplier with shielded dynode structure showed no delayed afterpulses. L. R. SHEPHERD

537.312.5

7291. Notes on the 931–A photomultiplier. M. J. SMYTH. *Mon. Not. Roy. Astron. Soc.*, **112**, 88–93 (*No.* 1, 1952).

A number of RCA 931–A photomultipliers have been examined, and their characteristics are compared with those of the 1P21. The reduction of dark-current is discussed. A method of examining local cathode sensitivity reveals that some tubes have markedly uneven sensitivity and may be unsuitable for astronomical applications. Types of stabilized power supply are discussed, and the effect of geomagnetism on photomultiplier sensitivity is verified. A.

537.312.5 : 621.383.27

7292. Performance of pulsed photomultipliers. R. F. POST. *Nucleonics*, **10**, 46–50 (*May*, 1952).

Up to 450 V per stage have been applied to type 931A and 1P21 photomultipliers by limiting the time of application of potential to a few hundred pulses per second of < 2–3 μsec duration. Under these conditions a total amplification of 10^9 is obtainable giving output pulses of 10 to 15 V across a 100 Ω load for single electrons from the photocathode. Display on the screen of a very fast oscilloscope is possible without additional amplification and limitation on the observable rise time is avoided. Photographs of single-electron noise pulses presented on an oscillograph screen with 0·08 μsec sweep, indicated

hat the duration of the anode current pulses was bout 5×10^{-10} sec and it was deduced that delay in econdary electron emission is $<7\times10^{-11}$ sec. bservations on emission times of certain organic hosphors are outlined and a fast coincidence circuit ith resolving time of 7×10^{-10} sec incorporating ulsed photomultipliers is described. L. R. SHEPHERD

537.312.5 : 771.534

Correlations between photographic and photo-onductive sensitivity of silver halides. *See Abstr.* 7843

537.312.62

7293. On the superconductivity of cadmium. B. N. AMOĬLOV. *Dokl. Akad. Nauk SSSR*, **81**, 791–4 (*No.* 5, 1951) *In Russian.*

The critical field curve of Cd was investigated; the superconducting transition was indicated by connecting a Cd wire (cooled through metallic contact with an adiabatically demagnetized salt) in parallel with the secondaries of two mutual inductances, and observing the a.c. signal from one of the primaries when the other was fed with a.c. current. It is claimed that this method gives a particularly sharp indication of the transition. The critical field-temperature relation was found to be of the form $H_c = H_0[1-(T/T_c)^2]$ with $H_0 = 28{\cdot}4 \pm 0{\cdot}3$ gauss and $T_c = 0{\cdot}547 \pm 0{\cdot}005$°K. These results are in fair greement with those of Goodman and Mendoza Abstr. 6979 (1951)]. D. SHOENBERG

537.312.62 : 530.162

7294. Statistical thermodynamics of the super-onducting state. H. ICHIMURA. *J. Phys. Soc. Japan*, , 233–40 (*May–June*, 1952).

An attempt has been made to interpret the superconducting state of the conduction electrons in the metal by the statistical mechanical treatment, introducting the second order effect of the lattice vibration on the electrons which has first been used by Fröhlich or this problem as the source of the attractive force n the momentum space. Using some reasonable implifications, the existence of a special equilibrium tate which is stable below a certain temperature can e shown. If this special state is considered as the uperconducting state, the jump of the specific heat ΔC and the threshold magnetic field curve which epresent well the experimental results can be calculated: $\Delta C = \gamma T_0$ (γ is the electronic specific heat oefficient and T_c is the transition temperature), $H = 2\pi^3 Nk^2(T_c - T)/3\mu_0$ (μ_0 is the Fermi energy, V is the number of the electrons in 1 cm³ and k is Boltzmann's constant). A.

537.312.62

7295. The effect of surface energy on the superconducting phase transition. M. P. GARFUNKEL. *Phys. Rev.*, **87**, 108–10 (*July* 1, 1952).

It is shown that a positive interphase surface energy eads to hysteresis in the superconducting-normal conducting phase transition in a magnetic field. The rgument is based on the simple thermodynamic heory of the phase transition. In view of these rguments, the magnetization curves of superconductors with various simple geometries are liscussed. It is shown that either superheating or upercooling or both may occur depending on the particular geometry involved. A.

537.312.62

7296. Search for low temperature superconductivity in graphite compounds. G. HENNIG AND L. MEYER. *Phys. Rev.*, **87**, 439–40 (*Aug.* 1, 1952).

Graphite and graphite compounds with Br, K, Ca, B, ammonium and bisulphate have been investigated for superconductivity down to 1·25°K. None became superconducting. A.

537.312.62

7297. On the displacement of transition temperature of superconductors by pressure. N. E. ALEKSEEVSKIĬ AND N. B. BRANDT. *Zh. Eksper. Teor. Fiz.*, **22**, 200–3 (*No.* 2, 1952) *In Russian.*

The pressure dependence of T_c of Au_2Bi, BiLi and Bi_2K was investigated by the ice-bomb technique [Lazarev and Kan, Abstr. 104 (1947)] the pressure being determined from the known value of dT_c/dp for In. dT_c/dp in °K dyne^{-1} cm² for Bi_2K was $5{\cdot}1\times10^{-11}$, for $Au_2Bi \sim -3\times10^{-11}$ and for BiLi negative also [no numerical data quoted, but from graph $\sim -6\times10^{-11}$]. Since Au_2Bi and Bi_2K are both cubic with nearly identical lattices any possible effect of pressure through change of crystal angles cannot be relevant in causing the opposite signs of dT_c/dp; it is suggested that the relevant factor may be change of electron concentration with pressure, and that the positive sign occurs only with Bi-rich compounds. D. SHOENBERG

537.312.62

7298. Properties of thin superconducting metal films. N. V. ZAVARITSKIĬ. *Dokl. Akad. Nauk SSSR*, **82**, 229–31 (*No.* 2, 1952) *In Russian.*

Films of Sn and Tl were evaporated on glass at 2°K; for films thicker than about 10^{-6} cm T_c was found to be about 4·6°K and 2·9°K for Sn and Tl respectively. For thinner films T_c began to decrease rapidly with thickness and below $1{\cdot}1\times10^{-7}$ cm for tin, i.e. 4 atomic layers ($T_c \sim 2$°K) and 4×10^{-7} cm for Tl ($T_c \sim 2{\cdot}3$°K) no superconducting transition was observed. For these non-superconducting films the resistance rose with decrease of temperature below 4·2°K; this rise, however, became less pronounced as the thickness was increased until for sufficiently thick films it changed over into a drop. For a tin film $3{\cdot}3\times10^{-7}$ cm thick it was found that a change in T_c of 0·01°K was produced by a field of 6000 gauss parallel, or of 25 gauss normal to the plane of the film. D. SHOENBERG

537.312.62

7299. Investigation of penetration depth of a magnetic field into a massive superconductor. II. YU. V. SHARVIN. *Zh. Eksper. Teor. Fiz.*, **22**, 367–75 (*No.* 3, 1952) *In Russian.*

Using the method described in Pt I [Abstr. 1458 (1949)] the temperature derivative $\partial\lambda/\partial T$ of penetration depth has been studied for two tin specimens whose surfaces were more perfect than that used in Pt I. The method of oscillating the temperature was also modified, this time being based on a periodic illumination of the thermally isolated specimen. In the neighbourhood of T_c the result $\lambda = 4{\cdot}6\times10^{-6}(T_c - T)^{-\frac{1}{2}}$ cm was found for small fields H, while the effect of the field was found to be given by $\partial\lambda/\partial T = (\partial\lambda/\partial T)_{H=0}[1 + \alpha(H/H_c)^2]$, with $\alpha = 0{\cdot}29$.

The result for small H agrees well with data of Laurmann and Shoenberg [Abstr. 7023 (1949)], though slight discordances appear at lower temperatures; the higher values of λ found in Pt I are attributed to poor surface conditions. The value of α is, however, much higher than found by Pippard [Abstr. 8754 (1950)] and also than predicted by the theory of Ginzburg and Landau [Abstr. 1017 (1952)].

D. SHOENBERG

537.312.62

7300. Critical remarks on the theory of superconductivity. M. v. Laue. *Ann. Phys.* [*Lpz.*] **10**, 296–301 (*No.* 4–5, 1952).

Remarks on the preceding paper on the "Theory of superconductivity," Max von Laue. F. London. *Ibid.*, 302–4.

Remarks on the theory of superconductivity. II. M. v. Laue. *Ibid.*, 305–9.

A special form of the electrodynamical potential of superconductors. F. Beck. *Ibid.* 310–13.

On the further "Remarks on the theory of superconductivity" of Mr. von Laue. F. London. *Ibid.*, 314–16. *In German.*

This controversy concerns certain calculations of the equilibrium between superconducting and normal phases in *Macroscopic theory of superconductivity* [F. London, *Superfluids*, Vol. I, New York, John Wiley & Sons (1950)]. The following are the main issues. V. Laue objects to the method of calculating the electrodynamic potential of a superconducting phase by substituting for the latter a diamagnetic body that produces the same external field as the superconductor. An explicit proof of the legitimacy of this procedure is given in the paper by Beck. Further, v. Laue objects to the method of determining the critical magnetic field from the equality of the thermodynamical potential of the superconducting and normal state in cases (e.g. for thin films) where electrodynamics does not permit a continuous transition from one state to the other. London's argument is that in these cases thermodynamics cannot predict whether a discontinuous transition actually takes place, but that it is of interest to look for the possible absence of an absolute equilibrium (hysteresis). It is stressed by London that the present ideas on the intermediate state and superconductors of small dimensions (which are based on a linear theory of the superconductor right up to the critical field) are not the last word in this matter and he refers to the new departures by Ginzburg and Landau [Abstr. 1017 (1952)] and by Pippard [Abstr. 7904 (1951)].

H. LONDON

537.312.8

7301. On the temperature dependency of magnetoresistance effect of iron single crystal. Y. Gondo and Z. Funatogawa. *J. Phys. Soc. Japan*, **7**, 41–3 (*Jan.–Feb.*, 1952).

Change of electric resistance of single crystal of Fe rod induced by magnetization was measured by usual potentiometer and galvanometer deflection method at high temperature up to the Curie point. From these results $(\Delta R/R)_{111}$ and $(\Delta R/R)_{100}$ at several temperatures are calculated. $(\Delta R/R)_{100}$ remains constant from room temperature up to near 300°C and then decreases gradually to zero at the Curie point with increasing temperature. $(\Delta R/R)_{111}$ tends very smoothly to zero at the Curie point with increasing temperature. The large decrease of resistance near the Curie point is not anisotropic. A.

ELECTRIC DISCHARGES 537.52

537.523.3

7302. An estimate of the energies of the positive ions in a negative point-to-plane corona. G. L. Weissler and M. Schindler. *J. Appl. Phys.*, **23**, 844–6 (*Aug.*, 1952).

An attempt has been made to measure the energies with which positive ions arrived at the cathode of a negative point-to-plane corona in N_2. A hairpin thermocouple was used as the point electrode. It was heated by the corona current, and its thermal e.m.f. was recorded by a galvanometer. After appropriate calibration, the potential across the Crookes dark space was determined to be about 300 V, and the average energy with which ions arrive at the corona point to be about 15 eV. A.

537.523.74

7303. High frequency electrical breakdown of gases. W. P. Allis and S. C. Brown. *Phys. Rev.*, **87**, 419–24 (*Aug.* 1, 1952).

Previous theoretical treatments of h.f. electrical breakdown in gases based on the Boltzmann transport equation were applied to specific gases and met with mathematical difficulties when applied to higher pressures. A simpler solution applicable to any gas and to a wide pressure range is presented. Agreement between theory and experiment with H gives confidence that the energy distribution function is correct and the distribution function is therefore used to compute other quantities of physical interest. A.

537.525 : 621.386.1

7304. Oscillographic study of the discharge in X-ray impulse tubes. E. M. Reĭkhrudel, A. A. Sanin and T. A. Titova. *Zh. Tekh. Fiz.*, **21**, 746–52 (*No.* 7, 1951) *In Russian.*

The discharge in cold-emission X-ray tubes with pulsed voltages from 100 to 300 kV is investigated using an oscillograph with delayed sweep and writing speed of 40 km/s. A slight "step," or delayed initial rise (0·1 to 0·5 μsec), and a 10 Mc/s oscillation, superimposed on the 400 kc/s fundamental, occur in some oscillograms of discharge current, and are discussed in terms of the discharge process. F. Quelon

537.525.8

7305. The positive column of a gas-discharge in a non-uniform magnetic field with axial symmetry. E. M. Reĭkhrudel. *Zh. Tekh. Fiz.*, **21**, 733–45 (*No.* 7, 1951) *In Russian.*

The effect of an external rotationally symmetrical magnetic lens on the kinetics of the plasma electrons in a glow- or arc-discharge, at various gas pressures and current densities, is studied by means of probes and the method of sectionalized anodes. Effects found are (*a*) a directional redistribution of the

electron current; (*b*) a spatial electron density redistribution; (*c*) alteration of the velocity distribution-function and temperature of the electrons. A sharply non-uniform magnetic field, as produced by two similar (axial) lenses in opposition, by reducing the ion concentration in the layer surrounding the probe, enlarges, and thereby weakens the screening action of the layer, making possible control of the discharge current by means of the probe voltage. F. QUELON

537.525.8

7306. The limits of stable existence of the positive column of a gas discharge. I. A. POLETAEV. *Zh. Tekh. Fiz.*, **21**, 1021–8 (*No.* 9, 1951) *In Russian.*

Calculation of the characteristics of the positive column of a gas discharge, based on an approximate curve of ionization of the gas, indicates the existence of an upper limiting value of the product radius of column × gas pressure, for stable existence of the positive column. Hitherto proposed explanations of the spontaneous extinction of large discharge currents have been inadequate, and the theory advanced by the author is claimed to give the conditions for stable existence and mechanism of extinction of the discharge. Results of experiments with Hg and 4 inert gases show a systematic divergence from calculated values, which is attributed to non-uniformity of the plasma usually existing under experimental conditions. F. QUELON

537.525.8

7307. Plasma oscillations and striae. G. V. GORDEEV. *Zh. Eksper. Teor. Fiz.*, **22**, 230–40 (*No.* 2, 1952) *In Russian.*

Theoretical. It is postulated that the velocity of striae in the positive column of a gas discharge is the group velocity of plasma oscillations. Using the relation between the frequency and wavelength of such oscillations derived by Landau (1946) the group velocity and the distance between successive group maxima, which is identified with the separation of individual striae, are calculated. Comparison with exptl. measurement on striae separation in H_2, N_2 and Hg shows very good agreement with theoretical predictions. Moving striae are obtained when the reflected wave from the cathode is rapidly damped by atomic collisions; this occurs most readily when the group velocity of the incident wave is high, and nearly equal to the electron drift velocity. When the reflected wave is insufficiently damped, interference between incident and reflected waves produces a continuous positive column. This is in accordance with the exptl. observation that in many gases, although the velocity of moving striae increases as the pressure is reduced, stationary striae are produced at a very low pressure, after passing through an intermediate pressure region in which the positive column is continuous. A sudden transition from moving to stationary striae should theoretically be possible in certain cases (e.g. H_2 and Hg) but in these cases moving striae have not yet been observed. A. SCHOFIELD

537.525.8

7308. Observations on discharges in magnetic fields. W. H. BERGMANN. *Acta Phys. Austriaca*, **5**, 425–8 (*No.* 4, 1952) *In German.*

A brief paper dealing with the effect of magnetic fields (longitudinal or oblique) on the appearance of glow discharges, at pressures $\sim 0{\cdot}05$ mm Hg. Six photographs are given. J. D. CRAGGS

537.525.9

7309. An investigation of the hydrogen discharge. A. S. POKROVSKAYA. *Zh. Tekh. Fiz.*, **21**, 617–24 (*No.* 6, 1951) *In Russian.*

A discharge tube 32 mm dia., 360 mm long, containing H_2 at pressures between 9 μ and 40 μ, and carrying currents of $0{\cdot}3$ A and $1{\cdot}0$ A was used. The tube was fitted with two axial cylindrical probes 150 mm apart, and with one flat probe at the wall surface between the two axial probes. Current-voltage characteristics of the probes were observed. The temp. of the electron gas, deduced from the probe characteristics, was found to lie between $50–60 \times 10^{3}$°K, falling slightly with increasing pressure; this value agrees closely with that for argon, for which the ionization potential is nearly equal to that of H_2. Satisfactory agreement was found between the exptl. results and theoretical predictions (following Tonks and Langmuir), on the assumption that the hydrogen ions are mainly molecular ions (H_2^+) and not protons (H^+). This assumption is supported by spectroscopic observation of a strong H_2 band spectrum and only a faint Balmer series. Calculation of the energy-balance in the positive column shows that for a current of $0{\cdot}3$ A, 52–60% of the total energy available is radiated as light, but that when the current is increased to 1 A, the proportion of luminous radiation falls to 38–46%. A. SCHOFIELD

X-RAYS 537.531

537.531 : 535.313

7310. Generalized Schwarzschild reflecting system for grazing-incidence X-ray optics. H. WOLTER. *Ann. Phys.* [*Lpz.*] **10**, 286–95 (*No.* 4–5, 1952) *In German.*

By allowing the integration constants of Schwarzschild's equations to take complex values, one can arrive at a strictly aplanatic two-mirror system for focusing X-rays. A number of possible systems are considered. See Abstr. 4380 (1952). A. R. STOKES

537.531 : 535.33.03 : 621.386.1

7311. An X-ray tube with transmission target for production of secondary X-ray spectra. H. HERGLOTZ. *Öst. Ingen.-Arch.*, **6**, 135–40 (*No.* 2, 1952) *In German.*

A tube having an Al target 20 μ thick, faced with $0{\cdot}3$ μ coating of Cu to produce characteristic radiation is described. Absorption in the target is only 22%, and the specimen, which is evaporated on to filter paper, is brought within 1 mm of the surface; thus secondary radiation of high intensity is applied to the spectrometer. The tube is operated at 25 kV, 10 mA and exposures of 1 hr are given. F. T. FARMER

537.531 : 535.339 : 548.733

7312. A point-focusing X-ray monochromator for the study of low angle diffraction. L. SHENFIL, W. E. DANIELSON AND J. W. M. DUMOND. *J. Appl. Phys.*, **23**, 854–9 (*Aug.*, 1952).

The anastigmatic point focus is achieved by means

of two cylindrically bent quartz crystals whose focal circles are mutually perpendicular. The beam, emanating from the copper target of an X-ray tube, is reflected in succession, first from the crystal defining the horizontal focal circle, and second from the crystal defining the vertical focal circle following which it comes to a monochromatic point focus of wavelength 1·537 Å (Cu $K\alpha_1$). The sample to be studied is placed between the second crystal and the point focus, and the scattered beam is detected by means of a photographic film placed at the point focus, at right angles to the undeviated beam, the latter being suppressed by means of an absorber, or allowed to pass through a hole in the film. Mathematical analysis, in which a ray was traced through the two-crystal system, revealed correctly the shape and size of the point focus, and the possibility of reducing the latter in size by stopping down the beam emerging from the target. [See also Abstr. 7595 (1952)]. A.

537.531 : 535.43

7313. The passage of X-rays through a plane-parallel crystal plate. Kh. Ya. Khristov. *Dokl. Akad. Nauk SSSR*, **81**, 799–802 (*No.* 5, 1951) *In Russian.*

Continuation of Abstr. 5926 (1952). A crystal lattice with one dipole per unit cell is irradiated with strictly parallel, monochromatic X-rays. The solution of a system of equations describing the process gives the Laue conditions for diffraction and an expression for the diffracted amplitudes. The latter is not in exact agreement with that first derived by Ewald.

A. L. MACKAY

537.531 : 535.43

7314. X-ray scattering by aggregates of bonded atoms. II. The effect of the bonds: with an application to H_2. R. McWeeny. *Acta Cryst.*, **5**, 463–8 (*July*, 1952).

For Pt I, see Abstr. 1042 (1952). The X-ray scattering from an aggregate of bonded atoms can be dealt with in exactly the same way as when interactions are neglected, provided the atomic scattering factors (f) are replaced by effective scattering factors (f^e). The effective factor depends upon atomic environment and its precise definition involves the resolution of the non-localized charge cloud, which describes the bonding electrons, into formal "atomic" components. f^e, which is generally a complex quantity, can be obtained from f by vector addition of a correction, Δf. The calculation of the correction involves the evaluation of a "bond scattering factor"; the method of integration employed for this purpose is fully described. Finally, the theory is applied to the case of a hydrogen atom in the hydrogen molecule. In this instance the correction required is large. f^e is found to depend strongly on the inclination of the scattering normal to the axis of the molecule: as this inclination decreases the pronounced asymmetry of the system introduces a considerable phase shift into the scattered beam. The correction is perhaps exceptionally large in this case; but the nature of the results throws some light on other problems involving "anomalous reflections." A.

537.531 : 537.542

Scintillation counters for X-rays. *See Abstr.* 7352

537.531.08

7315. A simple conversion of an X-ray dose-rate meter into an integrating dose-meter. C. L. Smith. Letter in *J. Sci. Instrum.*, **29**, 269–70 (*Aug.*, 1952).

The current from an ionization chamber is amplified (to about 5 mA) and passed through an electrolytic cell. The volume of gas evolved $\propto$ dose, being self-corrected for temperature and pressure, and doses of 100 r cause an easily measured fall in liquid level, of about 20 cm. F. T. FARMER

CATHODE RAYS . POSITIVE RAYS 537.533/.534

537.533.08 : 615.849

Film dosimetry of electrons in the energy range 0·5 to 1·4 million electron volts. *See Abstr.* 7800

537.533.72

7316. An integrable case of electron motion in electric and magnetic field. H. Poritsky and R. P. Jerrard. *J. Appl. Phys.*, **23**, 928–30 (*Aug.*, 1952).

Electron motion is studied in a two-dimensional electric field of potential $V = A + B(x^2 - y^2)/2$ and a uniform magnetic field $\mathbf{H} = (0, 0, -H)$ normal to the electric field, where A, B, $-H$ are constants. The equipotential lines of the electric field in any plane $z = \text{const.}$ consist of rectangular hyperbolas with a point of zero field strength at $x = 0$, $y = 0$. The differential equations of motion are integrated, and expressions are given for the electron paths. For this type of field, the electron motion consists of superposition of elliptic and hyperbolic motions, that is, of a simple harmonic motion along an ellipse whose centre moves along a hyperbola. The latter hyperbolas intersect the equipotential hyperbolas, so that, unlike the uniform crossed field case, the electron may drift into regions of higher or lower potential. A.

537.533.72

7317. The imaging properties of electron beams in arbitrary static electromagnetic fields. P. A. Sturrock. *Philos. Trans A*, **245**, 155–87 (*No.* 894, 1952).

Aims at constructing a complete theory of aberrations in electron-optical systems with curved axes, and demonstrating, by an example, its application to practical problems. An appropriate co-ordinate system is set up by means of a ray-axis together with its normal and binormal. The electric and magnetic fields are then investigated with the help of tensor calculus; the variational principle of electron optics is also put into tensor form. The integrand of the variational equation may be separated into a series of polynomials, one of which determines the paraxial imaging properties of the system and the rest of which determine the aberrations. The condition is established for which, upon an appropriate transformation, either of the paraxial ray equations contains only one off-axis co-ordinate. Subsequent investigations are restricted to systems, which are termed "orthogonal," for which this condition is satisfied. It is shown that, in a certain sense, no orthogonal electron-optical system can be wholly divergent. The second-order aberration and the zero-order and paraxial chromatic aberrations are then investigated by the method o

perturbation characteristic functions. All formulae are given in their relativistic forms but their non-relativistic forms are indicated; formulae are therefore given for the calculation of the zero-order and paraxial relativistic correction. It is indicated to what extent one forfeits control over the second-order aberration—and hence over the paraxial chromatic aberration also—by specifying that the paraxial behaviour of rays should be Gaussian. As an example, the imaging properties of a helical beam moving in the field of a pair of coaxial cylindrical electrodes are calculated. There is also an appendix which gives formulae for the effect upon aberrations of a change in the aperture position. A.

537.533.72 : 621.385.83 : 621.317.729

7318. Factors affecting the design of an automatic electron-trajectory tracer. K. F. SANDER, C. W. OATLEY AND J. G. YATES. *Proc. Instn Elect. Engrs, Pt III*, **99**, 169–78 (*July*, 1952).

For abstract see Abstr. 9524 (1951).

537.533.72 : 621.385.833

7319. Electron-optical bench. L. MARTON, M. M. MORGAN, D. C. SCHUBERT, J. R. SHAH AND J. A. SIMPSON. *J. Res. Nat. Bur. Stand.* [*Wash.*] **47**, 461–4 (*Dec.*, 1951).

A versatile electron-optical bench has been constructed for the extensive study of electron-optical elements. Three carriages for magnetic lenses and four holders for apertures, objectives and meshes are arranged appropriately in the vacuum chamber, while provision is made for external positioning with 3 degrees of freedom for each element. The design and experimental technique are discussed in detail. A set of measurements of the focal length of a magnetic lens is presented to illustrate the practical employment of the bench and to indicate the limits of accuracy that can be attained. A.

537.533.72 : 621.385.833

7320. Axially symmetric electron beam and magnetic-field systems. L. A. HARRIS. *Proc. Inst. Radio Engrs*, **40**, 700–8 (*June*, 1952).

The dynamics of hollow or solid beams in axial magnetic fields are analysed, assuming electrons do not cross each other radially. The focusing properties are due to the angular velocity, which depends on magnetic flux linkages in the beam and at the cathode. The position of the cathode in the magnetic field is thus of vital importance. Radial oscillations about an equilibrium radius are always stable in the presence of a magnetic field, and can be made stable even without a magnetic field. Design formulae are presented for two cathode arrangements; in the first the cathode is in a uniform magnetic field, while in the second it is inside a magnetically shielded structure. Special cases of each of these arrangements are considered. Limited experimental results confirm most of the theory presented, and indicate the possibility of focusing without a magnetic field over the beam. A.

537.533.72 : 621.385.833

7321. Spectrographic and electron optical features of directional double focusing. H. W. FRANKE. *Öst. Ingen.-Arch.*, **6**, 105–13 (*No.* 2, 1952) *In German.*

Mass and velocity dispersion, the inclination of the collecting plane and the size of the aperture disk error are expressed in terms of the coefficients derived by writing the field components in the form of series. The conditions for directional double focusing and for velocity and extended directional double focusing are also given. The possibility of second-order focusing is indicated. See also Abstr. 2739 (1951).

H. J. H. STARKS

537.533.72

7322. A uniform solenoidal magnetic field nuclear spectrometer. F. H. SCHMIDT. *Rev. Sci. Instrum.*, **23**, 361–6 (*July*, 1952).

The mechanical and electrical features of a ring image type spectrometer are described. The baffle system may be rolled out of the vacuum chamber for ease of adjustment. The predicted momentum resolution *v.* percent transmission has been verified; e.g. 0·4% resolution at 2% transmission. A close doublet in the internal conversion spectrum following β-decay of Cs^{134} has been observed. The lines differ in momentum by 0·6%. A.

537.533.72

7323. On the double coil magnetic lens β-ray spectrometer. T. AZUMA AND K. TSUMORI. *J. Phys. Soc. Japan*, **7**, 341–3 (*July–Aug.*, 1952).

Includes the calculated values of the electron orbits and the resolving powers and the experimentally evaluated value of the energy constant of the instrument by the analysis of the Co^{60}–γ. A.

537.533.74

7324. Polarization of electrons by scattering. I. N. RYU. *J. Phys. Soc. Japan*, **7**, 125–9 (*March–April*, 1952).

The double-scattering experiment has been repeated to find out the evidence for polarization expected by theories. The scatterers used were gold foils of about 5×10^{-6} cm in thickness and the energy of the electrons ranged from 60 to 130 keV. The experiments were carried out on the scattering through angles of 105° and 120° at the first and the second foil. At 120 keV the values of $-200\ \delta^2$ are $14\cdot7 \pm 1\cdot7$ and $16\cdot9 \pm 2\cdot0$, respectively, which are less than the half the theoretical values predicted by Mohr at 121 keV. The results at 120° are somewhat larger than those at 105°, but the mean errors in counting are too large to be compared precisely. The azimuthal dependency of the polarization effect agrees with the theory qualitatively. A.

537.533.74

7325. Polarization of electrons by scattering. II. N. RYU. *J. Phys. Soc. Japan*, **7**, 130–5 (*March–April*, 1952).

Investigation by double scattering where the scattering angles at the polarizer and the analyser are different was carried out. The results obtained $(-200\ \delta_1\delta_2)$ are $14\cdot1 \pm 1\cdot8$, $17\cdot0 \pm 3\cdot0$, $15\cdot7 \pm 2\cdot1$ and $20\cdot4 \pm 2\cdot8$ at 120 keV at angles of 105° — 120°, 105° — 135°, 120° — 105° and 120° — 135°, and are less than half of Mohr's theoretical values. The large differences between the evidences at angles of 90°, 105°, 120° and 135°, shown in Mohr's paper, could not be obtained. The plural scattering, which is the combination of rather large angle deflections at same foil, plays an important role in these experiments, but it is difficult by this cause alone to explain the discrepancy

between experiment and theory. But the evidences by polarization increase with scattering angles, and this tendency agrees with Mohr's theory. A.

537.533.74

7326. The scattering of fast electrons and positrons by heavy elements. E. M. GUNNERSEN. *Aust. J. Sci. Res. A*, **5**, 258–65 (*June*, 1952).

The angular distribution for the single elastic scattering of 1·07 MeV positrons and electrons by the Hartree field of Hg ($Z = 80$) is calculated. The results show no large deviations from Coulomb values except, possibly, a slight increase in the region of 90° for electrons. A.

537.533.74

7327. Multiple scattering of 0·59 MeV electrons. E. HISDAL. *Phil. Mag.*, **43**, 790–800 (*July*, 1952).

The multiple scattering of electrons of 0·59 MeV kinetic energy in G5 plates has been investigated. The experimentally determined mean of the absolute multiple scattering angle is found to be significantly lower than the value predicted by theory. A.

537.533.74

7328. Positron-electron scattering in helium. G. R. HOKE. *Phys. Rev.*, **87**, 285–9 (*July* 15, 1952).

Positron-electron scattering in a cloud chamber filled with He at a pressure of 105 cm of Hg has been studied. The positron source was Na^{22}, and the primary positron energies ranged from about 20 to 600 keV. On 2420 m of track length 1129 scattering events have been found with a fractional energy exchange between positron and electron greater than 10%. The frequency of scattering is in good agreement with the theory of Bhabha, but not enough events are available to discriminate between the theory with the effect of exchange taken into account and the theory without exchange (i.e. "ordinary" scattering). A.

537.533.74

7329. On the scattering of electrons in thin layers. S. LEISEGANG. *Z. Phys.*, **132**, 183–94 (*No.* 2, 1952) *In German.*

The scattering of electrons of energy between 2·0 and $6{\cdot}8 \times 10^4$ eV in layers of celluloid, Al, Ag and Au has been investigated theoretically and experimentally. The layers were of thickness between 100 Å and 1000 Å so that the electrons suffered only a small number (n) of collisions ($1 < n < 10$) in the layer. Graphs of relative intensities of the scattered beam against the angle of scattering indicate good agreement between theory and experiment.

P. T. LANDSBERG

537.533.74

7330. The scattering of fast electrons by light atomic nuclei. S. KRONENBERG. *Acta Phys. Austriaca*, **5**, 536–43 (*No.* 4, 1952) *In German.*

The angular distribution is calculated using a method similar to that of P. Urban (1942) but confirming the results of W. A. McKinley and H. Feshbach (1948). W. J. SWIATECKI

537.533.74

7331. On the simple scattering of fast electrons through small angles. F. LENZ. Note in *Naturwissenschaften*, **39**, 265 (*No.* 11, 1952) *In German.*

The differential scattering cross-section for 50–100 kV electrons and scattering angles $\ll 0{\cdot}1$ is obtained from the Wentzel density distribution, using the diamagnetic susceptibility of the scattering medium for calculating the Wentzel atomic radius. Agreement with experiment is better than for the Thomas–Fermi distribution. J. A. FRANKS

537.533.75

7332. On the energy loss of fast electron. S. KAGEYAMA AND K. NISHIMURA. *J. Phys. Soc. Japan*, **7**, 292–6 (*May–June*, 1952).

The energy distribution, the most probable and the average energy loss of electrons passing through matter were measured with a 180° focusing spectrometer of approximately 0·7% resolution, using K conversion lines of 606, 1414 and 1761 keV γ-rays of RaC′ as homogeneous electron source and the various thicknesses of Al, Cu, In and Pb as stopping materials. The observed value of the most probable energy loss was in accord with Landau's theory within the limits of the experiment. That of the average energy loss, however, was not in accord with his theory but with Bloch's formula. The width of the energy distribution curve obtained was considerably greater than predicted by Landau. However, on the high-energy side of the peak, the shape of the curve predicted by Landau's theory was better than that of White and Millington's. A.

537.533.75

7333. On the range-energy curve for slow electrons in nuclear emulsions. B. GAUTHE AND J.-M. BLUM. *C.R. Acad. Sci.* [*Paris*] **234**, 2189–91 (*May* 26, 1952) *In French.*

Using the method previously described [Abstr. 3617 (1952)] a more accurate determination has been made of four points on the range-energy curve for electrons of energies 8 to 20 keV. A. C. COATES

537.533.8 : 539.234

7334. Radiation from freshly evaporated layers of metal and salts. H. GOBRECHT AND G. BARSCH. *Z. Phys.*, **132**, 129–39 (*No.* 2, 1952) *In German.*

The following effect, apparently discovered by Russell (1897) was investigated. If a clear glass plate is covered with an evaporated film of e.g. Al or NaCl, and is then laid with its coated face on a photographic plate, the plate shows a pattern on development. The effect is due to low-energy (~ 40 eV) electrons. Contrary to the statements of Kramer [*Der metallische Zustand*, Göttingen (1950)], the effect does not relate to the transition from the amorphous to the metallic state, but depends on oxidation or adsorption. The effect of scratches, layer thickness, the support material, etc., is to influence the reaction speed.

A. H. W. BECK

537.533.9

7335. Radiation loss by electrons in large orbits. D. R. CORSON. Letter in *Phys. Rev.*, **86**, 1052–3 (*June* 15, 1952).

This was studied by measuring how the orbit radius in a synchrotron changes with time when the r.f. accelerating voltage is removed. Essential agreement with the classical formula was found.

W. J. SWIATECK

537.534 : 539.152.1

7336. Possibilities of heavy ion bombardment in nuclear studies. G. Breit, M. H. Hull, Jr, and R. L. Gluckstern. *Phys. Rev.*, **87**, 74–80 (*July* 1, 1952).

Bombardment of nuclei by multiply charged ions of medium atomic weight such as C^{12} or O^{16} is considered as a possible means of studying nuclear structure. Estimates are made regarding the approximate magnitude of: (*a*) distortion effects in target nuclei produced by the incident particles, (*b*) consequences of the distortion such as effects on thresholds of reactions having their origin in Coulomb barriers, (*c*) stimulation to fission, (*d*) effects characteristic of the leakage of neutrons and protons out of the two colliding nuclei by wave-mechanical penetration of the regions of negative kinetic energy; an exploration of these effects should amount to a study of the halo of neutrons and protons surrounding the more compact nuclear interior and might be helpful in determining the number of nuclear particles at the nuclear surface having a given energy. The treatment is qualitative and the mathematical discussion involves many approximations. General design characteristics of a 60 in cyclotron that should be capable of imparting the necessary energy to multiply charged ions are considered. A.

537.534 : 621.384.62

7337. 1·2 MeV accelerator at the Australian National University. E. W. Titterton. *Nucleonics*, **10**, 28–9 (*May*, 1952).

The machine is built around a 7-stage Cockroft–Walton generator giving a terminal voltage of 1·2 MV with a current of 3 mA. A r.f. current circulated around the multiplying circuit provides rectifier cathode heating. A smoothing column of 7 capacitors and a compensating a.c. voltage reduces the maximum load ripple to a first harmonic component < 100 V. The accelerator tube has 7 stages each separated from the next by a 2–2·5 cm aperture electrostatic lens, the appropriate d.c. potentials at the lenses being tapped off the smoothing column. The lenses reduce X-ray background by stopping secondary electrons traversing more than one stage. An Oliphant-type ion source giving $\sim 30\%$ protons is used at present, the maximum beam so far obtained being 300 μA at 880 keV. L. R. Shepherd

537.534.74

7338. Inelastic scattering of protons from light nuclei. D. B. Cowie, N. P. Heydenburg and G. C. Phillips. *Phys. Rev.*, **87**, 304–6 (*July* 15, 1952).

An investigation has been made of inelastic scattering of 7·4 MeV protons at 90° from the following thin foil targets: Be, C^{12}, C^{13} (47% enriched), CaF_2, Ni, Al and Na, and from the following gas targets: normal BF_3, enriched $B^{10}F_3$ (96%), N_2, O_2, CH_4 and Ne. The following energy levels in MeV were observed: Be^9 2·57; B^{10} 2·34; B^{11} 2·06; C^{12} 4·59; C^{13} 3·14, 4·03; N^{14} 2·35, 3·95; O^{16} none; F^{19} 1·53, 3·83; Ne 1·44, 4·36; Na^{23} 3·67; Al 1·02, 2·30, 2·89, 3·32, 4·48; Ni 1·44. A.

537.534.74

7339. An optical model for nucleon-nuclei scattering. R. E. Le Levier and D. S. Saxon. *Phys. Rev.*, **87**, 40–1 (*July* 1, 1952).

The model is one in which the interaction is described by a complex square well potential $V(r) = -V_0 - iW_0$, $r < R_0$. Comparison with experiment indicates that for the scattering of 18 MeV protons by Al, reasonable agreement is obtained using well parameters which are consistent with the requirement of the transparency model and of low-energy neutron scattering. The boundary condition model of Feshbach and Weisskopf has also been examined and a region of quasi-equivalence indicated for the two models. A.

537.534.75 : 537.542

Application of multiple scattering theory to cloud-chamber measurements. *See Abstr.* 7355

537.534.75

7340. The range-energy relation for protons in aluminium. D. H. Simmons. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 454–6 (*June*, 1952).

A 10 MeV proton beam was detected in nuclear emulsions both directly and after passing through an Al absorber. The absorption predicted by Smith [Abstr. 1232 (1947)] was found to be about 0·8% too low. F. R. Holt

537.534.75

7341. The stopping cross section of D_2O ice. W. A. Wenzel and W. Whaling. *Phys. Rev.*, **87**, 499–503 (*Aug.* 1, 1952).

The energy loss of protons and deuterons in D_2O ice has been measured over the energy range $E_p = 18 - 541$ keV using the double focusing magnetic spectrometer to measure the energy of the particles after they have traversed a known thickness of the ice target. One method of measurement is used to determine relative values of the stopping cross-section as a function of energy, another method measures the absolute values. The results are in very good agreement with the values calculated from Bethe's semi-empirical formula. Possible sources of error are considered and the accuracy of these measurements is estimated to be $\pm 4\%$. A.

DISCHARGE TUBES . COUNTERS 537.54

537.541

7342. The aging phenomenon in inert gas discharge tubes. M. Miyanishi and K. Watadani. *J. Phys. Soc. Japan*, **7**, 66–8 (*Jan.–Feb.*, 1952).

The white light emitted from a neon discharge tube at its initial discharge, changes to red gradually with the time of discharge. This ageing phenomenon was studied by a spectroscopic method. The white light mainly was that of Ångström bands of CO molecules. The recombination of C atoms and O atoms produced by the dissociation of CO molecules in the tube was arrested by the Ne gas. The C thus freed, therefore, was fixed on the wall of the tube gradually. This was the main cause of the phenomenon. A similar phenomenon was observed in the case of He discharge tubes. A.

537.542

7343. A magnetic ion source of capillary arc type. A. ISOYA. *J. Phys. Soc. Japan*, **7**, 275–83 (*May–June*, 1952).

In the quartz capillary part (8 mm dia., 10 cm in length) of this ion source with a coaxial magnetic field of about 800 gauss, an intense ionization is established by a collimated primary electron beam sent from one end of the capillary. No metal part being contained in the capillary, a high relative concentration of atomic H is obtained, so that the proton percentage of the ion beam extracted from the other end of the capillary is very large (60 ~ 70%). A proton output up to 1 mA is obtained from a 1·3 mm hole with a small consumption of power (< 200 W) and H gas (~ 3 ml per hour N.T.P.). The ratio of protons to consumed gas molecules is 10 ~ 20%. A.

537.542

7344. Counting losses of long beaded counters for X-ray measurements. I. NONAKA. *J. Phys. Soc. Japan*, **7**, 89–92 (*Jan.–Feb.*, 1952).

It has been verified experimentally that a G.M. counter having several glass beads on its central wire is very useful in X-ray measurement because of its low counting losses [Abstr. 1123 (1951)]. The counting losses of such beaded counters were calculated theoretically in several cases. The losses are reduced to about $1/n$ of non-beaded counters in the cases of short wavelengths, n being the number of sections, and this factor increases with the wavelength of X-rays. The effect of the finite ranges of secondary electrons in the counter gas is negligibly small, and the effect of the finite spreading probability of counter discharges beyond the beads is to increase slightly the reducing factor. A.

537.542

7345. The end effects in Geiger Mueller counters. R. ITO. *J. Phys. Soc. Japan*, **7**, 256–60 (*May–June*, 1952).

The end effects—namely the diminution of the effective length and the change of counting probability at the end—in G.M. counters which have considerably thicker rods at both ends of the central wire than the wire itself are experimentally investigated under various conditions of the filling, and some theoretical interpretations for them are tried. The agreement of the experimentally observed results with the theoretically expected ones is fairly good, and it may be concluded that the diminution of the effective length depends not only upon the bend of the lines of electric field but also upon the centrifugal force which affects the primary electrons traversing along the curved line, and that the change of counting probability at the end of the thin wire is caused by the diffusion of the primary electrons in the axial direction. A.

537.542

7346. Statistical relations connected with the registration of ionizing pulses. M. I. PODGORETSKIĬ. *Zh. Eksper. Teor. Fiz.*, **22**, 152–9 (*No.* 2, 1952) *In Russian.*

The frequency of accidental pulses due to background is analysed. Formulae are derived for the principal methods of use of the ionization chamber: threshold registration, continuous oscilloscope registration, measurement of convection current.

W. J. SWIATECKI

537.542

7347. On the fluctuations of electronic and ionic pulses, produced by the passage through an ionization chamber of a shower of relativistic particles. M. I. PODGORETSKIĬ. *Zh. Eksper. Teor. Fiz.*, **22**, 160–3 (*No.* 2, 1952) *In Russian.*

This is in connection with the new method of detecting ionizing pulses [Abstr. 621 (1949)].

W. J. SWIATECKI

537.542 : 539.166.08

Measurement of cesium-137 and cobalt-60 gamma radiation with a pressure ionization chamber. *See Abstr.* 7529

537.542 : 539.172.4

7348. Ionization measurement of $B^{10}(n, \alpha)Li^7$. J. RHODES, W. FRANZEN AND W. E. STEPHENS. *Phys. Rev.*, **87**, 141–5 (*July* 1, 1952).

A thin layer of B on the wall of a cylindrical ionization chamber exposed to slow neutrons has been used to study the ionization produced by the recoiling particles of the transmutation $B^{10}(n, \alpha)Li^7$. Po α-particles were used for calibration, and the ionization electron pulses were amplified and photographed on an oscilloscope screen. Calculated peak shapes taking into account wall effect and layer thickness were fitted to the experimental number/pulse-height curves, and from this information the ionization values were deduced. The ratio of ionization produced by the He^4 and Li^{7*} recoils was observed to be $1{\cdot}878 \pm 0{\cdot}014$ as compared to the energy ratio $1{\cdot}7529$ determined from conservation of momentum. This difference can be accounted for with the assumption that the average energy per ion pair varies with velocity. The implications of this assumption are discussed. A

537.542

7349. A light effect of a diamond alpha ray counter. S. KOJIMA AND S. KONO. *J. Phys. Soc. Japan*, **7**, 84–8 (*Jan.–Feb.*, 1952).

A diamond, cut in the form of plate, was coated on the parallel faces with evaporated Al. When the crystal was bombarded by α-rays on the side, the counting rate was decreased by light. The wavelength responsible for the effect was about 5000 Å. This light, applied more than one hour, did not increase the rate. In this point the effect differed from that of Willardson and Danielson. In the case of the bombardment through an electrode surface an opposite effect appeared. The rate was increased by the irradiation of the visible light to an equilibrium value, which depended on the wavelength. But light including u.v., which causes a remarkable photo ionization, decreased the rate after the maximum point. The increasing effect is understood by the release of the space charge as in the experiment of Chynoweth. The decreasing effect is attributed to the recombination of the carrier with the trapped electron by the aid of light, for the effect is observed only with charge carrier drift in the plasma layer where both electrons and holes are trapped. A

537.542

7350. Large-area liquid scintillation counters. F. B. HARRISON. *Nucleonics*, **10**, 40–5 (*June*, 1952).

The properties of various liquid scintillators (particularly absorption of the fluorescent light in the solvent) are reviewed. The relative merits of multipliers of the 1P21 and 5819 (end cathode) types are discussed and large volume liquid scintillation counters employing both types are described. The factors governing light collection in these large counters are examined. L. R. SHEPHERD

537.542

7351. Resolving time of scintillation counters. R. F. POST. *Nucleonics*, **10**, 56–8 (*June*, 1952).

An expression is derived giving the fluctuation in the time for the emission of a given number of photoelectrons, in terms of the average total number emitted and the decay time of the scintillator. The analysis is extended to take into account the spread in time taken for the light to pass down a light pipe. It is concluded that with the fastest available scintillators the shortest possible resolving time is about 3×10^{-10} sec, or almost double this value if a light pipe of one foot length is used. Improvement by an order of magnitude would be possible with a Cerenkov detector. L. R. SHEPHERD

537.542 : 537.531

7352. Scintillation counters for X-rays. G. BROGREN AND C.-G. RYLANDER. *Ark. Fys.*, **4**, 495–9 (*Paper* 33, 1952).

Crystals of $CdWO_4$ phosphor ($5\times5\times12$ mm) give scintillations with hard X-rays but have low response efficiency to Cu $K\alpha_1$ radiation. NaI–Tl crystals ($7\times7\times3$ mm) give 100% efficiency for X-rays of wavelength shorter than 140 Å. G. F. J. GARLICK

537.542 : 614.898 : 621.318.572 : 621.387.42

7353. A radiation monitor for demonstration purposes. K. E. G. PERRY AND F. S. GOULDING. *J. Sci. Instrum.*, **29**, 243–6 (*Aug.*, 1952).

A brief description is given of the circuit and layout employed. The instrument is of the standard Geiger counter counting-rate circuit type, attention being concentrated on the provision of clear circuit identification. A.

537.542 : 621.383.27

7354. Pulse-height resolution and photosensitivity. R. K. SWANK AND W. L. BUCK. *Nucleonics*, **10**, 51–3 (*May*, 1952).

The pulse-height resolution R of a photomultiplier is defined as the reciprocal of the fractional mean square deviation of output pulse amplitude for equal light pulses. This should be proportional to the number of cathode electrons per pulse (Nc), the proportionality constant F ($R = FNc$) being regarded as a figure of merit of the photomultiplier. Experiments in which F was measured in 14 type 5819 photomultipliers are described. Collimated Pu^{239} α-particles incident on NaI(Tl) was employed as a light source. Nc was determined from the average anode charge per pulse and the d.c. gain of the multipliers measured with steady light excitation. Small corrections are required for source resolution (light pulse variation) and loss of statistics in pulse shaping. L. R. SHEPHERD

537.542 : 537.534.74

7355. Application of the multiple scattering theory to cloud-chamber measurements. I. S. OLBERT. *Phys. Rev.*, **87**, 319–27 (*July* 15, 1952).

Some questions concerning the application of the multiple scattering theory to the analysis of cloud-chamber pictures are discussed from the theoretical point of view: (*a*) The Molière theory of multiple scattering is modified by the consideration of the finite nuclear dimensions. It is assumed that the probability of single scattering goes abruptly to zero for angles greater than $\phi_0 = \phi_m a/r_n$, where a is the radius of the statistical Thomas–Fermi atom, r_n the radius of the nucleus, and ϕ_m is the screening angle as derived by Molière. The distribution function for plural and multiple scattering is then derived for finite values of ϕ_0. It is shown that the cut-off affects especially the tail behaviour of the distribution function as it was to be expected. While Molière's function decreases as ϕ^{-3} for projected angles of scattering large compared to the r.m.s angle, the modified function decreases approximately as $(1/\phi)$ times a Gaussian function of $(\phi - \phi_0)$ for angles large compared to the r.m.s angle and the cut-off angle. (*b*) The distribution function for the mean value of the square angle of scattering in n plates of a multiple-plate cloud chamber is derived and compared with the normal χ^2-distribution. (*c*) The effect of observational errors on the distribution function for multiple scattering is estimated quantitatively and discussed in some detail for the case where the mean-square angle of real scattering is large compared to the variance of the noise level scattering. A.

IONIZATION . THERMIONICS 537.56/.58

537.56

7356. Negative ions of selenium, tellurium, antimony, and bismuth. V. M. DUKELSKIĬ AND N. I. IONOV. *Dokl. Akad. Nauk SSSR*, **81**, 767–9 (*No.* 5, 1951) *In Russian.*

Describes experiments showing the existence of free ions of Se^-, Se_2^-, Se_3^-, Se_4^-, Te^-, Sb^-, Sb_2^-, Sb_3^-, Bi^- and Bi_2^-. The ions were analysed by means of a magnetic mass-spectrometer. F. LACHMAN

537.561

7357. Mass spectrometric determination of the ionization potential of heavy ammonia ND_3. H. NEUERT. Note in *Z. Naturforsch.*, **7a**, 293–4 (*March–April*, 1952) *In German.*

The value found by measuring the ion yield as a function of the energy of the bombarding electrons was 10·72 V, 0·22 ± 0·05 V higher than for NH_3.
W. J. SWIATECKI

537.561 : 539.153

7358. On the average excitation potentials and the range-energy relations in light elements. M. BOGAARDT AND B. KOUDIJS. *Physica*, **18**, 249–64 (*April*, 1952) *In French.*

Using the authors' method [Abstr. 8805 (1951)] average ionization potentials I of light elements were

deduced from existing data with the maximum possible accuracy. It appears that I is constant within a limited energy range only. The results were inserted in Bethe's formula to calculate range-energy relations of α-particles in H, He, N, O, Ne, Al, A and CO_2. Excellent agreement with experimental points was found. The work of Mano (1934) and Rosenblum (1928) on ranges was reduced to absolute values. The constant of proportionality in Bloch's relation between I and Z was determined as $I = (12{\cdot}7 \pm 0{\cdot}4)Z$. W. J. SWIATECKI

537.562

7359. Mass spectra of deuteroacetylenes, monodeuterobenzene, and deuteronaphthalenes. F. L. MOHLER, V. H. DIBELER, L. WILLIAMSON AND H. DEAN. *J. Res. Nat. Bur. Stand.* [*Wash.*] **48**, 188–92 (*March*, 1952).

Mass spectra at 70 V ionizing voltage have been measured for C_2H_2, C_2HD, C_2D_2, C_6H_6, C_6H_5D, $C_{10}H_8$, $C_{10}H_7D$ and for a mixture of $C_{10}D_8$ and $C_{10}HD_7$. In acetylene, benzene and naphthalene it is possible to measure the isotopic purity at ionizing voltages below the appearance potential of any fragment ions and to correct the observed spectra of monodeutero compounds for isotopic impurity. For C_2HD the probability of removing the H atom is nearly twice as great as that of removing the D atom. In monodeutero benzene and naphthalene, on the other hand, there is no such selectivity, and it is possible to compute the spectra of the monodeutero compounds on the basis of equal *a priori* probability of removing a single H or D atom. By assuming that equal probability holds for doubly charged ions, the complete doubly charged ion spectra can be computed from the observed half-integer peaks. Similarly, the spectra of $C_{10}D_8$ and $C_{10}HD_7$ are computed from a spectrum of a mixture of the two compounds. A.

537.562 : 533.7

7360. Diffusion and excitation transfer of metastable helium in normal gaseous helium. R. A. BUCKINGHAM AND A. DALGARNON. *Proc. Roy. Soc. A*, **213**, 506–19 (*July* 22, 1952).

The resonance collision of normal and metastable helium atoms has been investigated, and cross-sections calculated for total elastic scattering, diffusion and transfer of excitation. The theoretical diffusion coefficient of metastable atoms in normal helium agrees reasonably well with experimental results of Ebbinghaus and Biondi. As a consequence of a potential barrier in the interaction of the atoms at large separations, the transfer cross-section shows an unusual variation, being small for low collision energies and reaching a maximum of the order of $10\pi a_0^2$ for collisions about 0·25 eV energy. Comparison is made with experiments by Reynolds. A.

537.563

7361. A comparison of the mass spectra of singly and doubly charged hydrocarbon ions. A. HENGLEIN. Note in *Z. Naturforsch.*, **7a**, 297–9 (*March–April*, 1952) *In German.*

This was done by means of a parabolic spectrograph for hydrocarbons up to the C_5 series and regularities concerning bindings in the molecules were deduced. W. J. SWIATECKI

537.567

7362. Acceleration of the de-ionization of a rarefied gas by means of back-voltage. B. G. MENDELEV. *Zh. Tekh. Fiz.*, **21**, 710–12 (*No.* 6, 1951) *In Russian.*

Previous work [Abstr. 6289 (1951)] with a 70 mm dia. Hg vapour tube had shown the influence of the anode electric field on de-ionization to be confined to a zone adjoining the anode, and spreading outwards from it with time. Formulae for calculation of the rate of de-ionization at a given point, both before and after it is reached by this zone of back-voltage influence, are derived. F. QUELON

537.568

7363. Measurement of the probability of attachment of electrons to oxygen by a transit time method. A. DOEHRING. *Z. Naturforsch.*, **7a**, 253–70 (*March–April*, 1952) *In German.*

An experimental method similar to that of Tyndall, Starr and Powell [Tyndall, *The Mobility of Positive Ions in Gases*, Cambridge (1938), p. 14] has been used for determining the attachment probability of slow electrons. The apparatus is described in detail, and the results obtained are compared with those of previous investigators. F. LLEWELLYN JONES

537.581 : 538.221

7364. Thermoelectronic emission in ferromagnetic materials. A. V. SOKOLOV AND A. Z. VEKSLER. *Dokl. Akad. Nauk SSSR*, **81**, 27–30 (*No.* 1, 1951) *In Russian.*

The "anomalies" of the ferromagnetic materials are usually explained by a spontaneous magnetization. This suggests that the anomaly of the thermoelectric emission in the ferromagnetic materials might be explained by the vanishing of this spontaneous magnetization at the Curie point. After recalling the Richardson emission formula, which was based upon the theory of an electron gas with Maxwell's distribution of velocities, and a modified emission formula due to Dushman, which was based upon the quantum mechanical analysis with the application of the Fermi statistics, the author comes to the consideration of the electron emission from ferromagnetic materials on the basis of the model due to C. V. Vonsovskiĭ (1946). In this model the thermoemission is regarded as a result of an interaction between two electron gases, one consisting of "s" electrons with vector spin σ and quasi-impulse vector k and located in the surface zone, and the other consisting of "d" electrons, with a mean relative atomic magnetic moment y, which originates from the depth of the ferromagnetic body. The energy of s electrons will be $E = \alpha - \alpha' y\sigma + (\beta + \beta' y\sigma)k^2$, where α, α', β, and β' are parameters depending on exchange integrals between these two electron gases. On the basis of these relationships the expression is evolved for the probability for an electron of a given velocity to pass through the surface zone of the ferromagnetic body, and then the integral expressing the rate of electron emission from a ferromagnetic body as a function of its temperature is derived from this expression by applying the standard statistical methods. The resulting formulae are rather cumbersome, but by restricting to the first approximation the expressions are obtained for the emission current as a function of the abs. temperature T in the form $T^{5/2} \exp(-\chi/kT)$. In the author's opinion, the

5/2 power instead of the usual square is due to the method of approximation used in this case. In the author's view, the results of A. B. Cardwell's experiments on the photoelectric effect in Ni [Abstr. 7112 (1949)] show that an anomaly near Curie point really occurs, and he suggests that the formulae derived in the present paper should be tested experimentally.

N. S. JAPOLSKY

537.583

7365. The decay and recovery of the pulsed emission of oxide-coated cathodes. R. M. MATHESON AND L. S. NERGAARD. *J. Appl. Phys.*, **23**, 869–75 (*Aug.*, 1952).

The decay and recovery of the pulsed emission of cathodes consisting of BaO on Ni are studied. The emission of the cathodes is measured in diodes of cylindrical geometry having water-cooled copper anodes spaced 0·019 in from the cathode. Most of the diodes show a decay of anode current when first put in pulse operation. Decays of 2–50% are observed during 150 μs pulses. The decay tends to disappear when the tubes are aged under pulse conditions. The peak current is a linearly decreasing function of the logarithm of the duty cycle, even when there is no perceptible decay during the pulses. The rate of decrease is independent of the pulse repetition rate and decreases with cathode temperature. Current-voltage characteristics during the pulse and recovery periods are obtained by short sampling pulses. A comparison of these characteristics with computed ideal characteristics does not discriminate unambiguously between a variation of emission and a variation of internal cathode impedance as a source of current decay. Studies to separate the contributions of these effects are in progress. A.

537.583 : 539.16.08

7366. The use of radioactive isotopes in a study of evaporation from thermionic cathodes. W. F. LEVERTON AND W. G. SHEPHERD. *J. Appl. Phys.*, **23**, 787–92 (*July*, 1952).

Radioactive tracers have been used in a study of evaporation of the alkaline earths Ba, Sr, and Ca from oxide coatings on passive Ni bases. Several percent of the total cathode Ba, Sr and Ca leave a triple oxide cathode during processing and ageing. The rates of transfer of these elements from the cathode during life tests of 118 hours at true cathode temperatures from 1175 to 1279°K obey equations of the form $\log W = A - (B/T)$, where W is the rate of transfer in g/cm²/sec, T is the absolute temperature of the cathode, A and B are constants. The transfer of Ba from a BaO cathode obeys a similar law. The mass of Ba transferred in 118 hours of life from a triple oxide cathode at 1123°K true as $2{\cdot}9\times10^{-6}$ g/cm², and from a BaO cathode $1{\cdot}4\times10^{-5}$ g/cm². The masses of Sr and Ca transferred from a triple oxide cathode at the same temperature were $2{\cdot}1\times10^{-7}$ and $1{\cdot}2\times10^{-8}$ g/cm², respectively. Bombardment of the anode by an electron beam during life tests decreased the quantity of Sr observed on the anode. Anode current densities of 5 to 10 mA/cm² at electron energies of approximately 100 V produced a fiftyfold reduction in the quantity of Sr on the anode. Experiments indicated that this decrease was not due to heating of the anode. The quantity of Ba deposited on the anode was not decreased by electron bombardment. The very considerable transfer of Ba from the cathode during processing was greatly reduced by breaking down the carbonates and high temperature flashing the cathodes in the presence of a few mm pressure of A gas. A.

COSMIC RAYS 537.591

537.591

7367. A heavy particle selector. T. DUERDEN AND B. D. HYAMS. *Phil. Mag.*, **43**, 717–23 (*July*, 1952).

A system of Geiger counters and a Cherenkov light detector is described which responds selectively to the passage of slow cosmic-ray particles heavier than about 550 electron masses. It has been shown to count at a rate consistent with the known flux of sea level protons, and cloud chamber photographs show that at least 80% of the counts are caused by protons of range less than 170 g cm^{-2} Pb. A.

537.591.1

7368. The abundance of lithium, beryllium and boron in the primary cosmic radiation. A. D. DAINTON, P. H. FOWLER AND D. W. KENT. *Phil. Mag.*, **43**, 729–52 (*July*, 1952).

In a previous paper [Abstr. 5532 (1951)], a method of determining the charge of heavy nuclei in the cosmic radiation was described whose results suggested the presence of a large proportion of the light elements Li, Be and B in the radiation, a result in contradiction with that of other workers. The first part of the present paper describes a re-examination of the original method and evidence for its reliability. It is shown that an alternative method, based on observations of grain-density in the tracks of heavy particles recorded in less sensitive emulsions, gives results in agreement with those obtained by the δ-ray method. In the second part, the results of a more extended series of measurements by the δ-ray method are described. The results indicate that at geo-magnetic latitude 55° N, the flux of Li, Be and B nuclei in the cosmic radiation is equal to, or larger than that of C, N and O. Finally, the bearing of the results on the origin of the cosmic radiation is briefly discussed. A.

537.591.1

7369. Note on the differential momentum spectrum of cosmic ray protons at sea level. C. M. YORK. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 558–9 (*July*, 1952).

The data at present available for the momentum region $0{\cdot}34$–$1{\cdot}35\times10^9$ eV/c is summarized. H. ELLIOT

537.591.1

7370. The hard component of cosmic rays in the upper atmosphere. M. A. CLARK. *Phys. Rev.*, **87**, 87–90 (*July* 1, 1952).

An experiment has been performed in the upper atmosphere to study charged cosmic-ray particles that penetrate 20 cm of lead. These particles were divided into two groups depending on whether or not they interacted on traversing the lead. The experimental equipment, which consisted of the lead absorber, G.M. tubes in coincidence and radio telemetering devices, was carried to high altitudes by an array of 36 balloons. The rate of occurrence of particles in

the two groups was determined as a function of atmospheric depth from 16 g-cm^{-2} to 400 g-cm^{-2}. The experimental results can be interpreted in terms of high-energy protons and μ-mesons, with corrections for low-energy protons and primary α-particles. The results are consistent with a primary proton intensity equal to $0{\cdot}19$ cm^{-2} sec^{-1} sterad^{-1}, an absorption length in air of 110 g-cm^{-2} for high-energy protons, and the μ-meson production spectrum given by Sands. A.

537.591.15

7371. On the nature and the mechanism of production of particles in extensive atmospheric cosmic ray showers. L. Kh. Eĭdus. *Dokl. Akad. Nauk SSSR*, **81**, 1035–8 (*No.* 6, 1951) *In Russian.*

A detailed discussion of existing data on the spread and absorption of such showers indicates that at a depth inside the atmosphere the nuclear-active and electron-photon components reach a state of equilibrium (initially the former predominates). Experiments on the proportion of penetrating particles at the periphery of such showers supporting the equilibrium hypothesis are reported. W. J. SWIATECKI

537.591.15

7372. The nature of cosmic-ray bursts underground. C. N. Chou. Letter in *Phys. Rev.*, **86**, 1048–9 (*June* 15, 1952).

The size-frequency spectrum for cosmic-ray bursts under 60 m water equivalent is discussed and it is pointed out that the burst frequency underground may be influenced by the contribution of μ-mesons arising from the decay of κ-mesons. H. ELLIOT

537.591.15

7373. A method of interpreting the distribution in multiplicity of shower secondaries. J. Linsley. Letter in *Phys. Rev.*, **86**, 1050–1 (*June* 15, 1952).

537.591.15

7374. A study of penetrating cosmic-ray showers in water. G. W. Rollosson. *Phys. Rev.*, **87**, 71–4 (*July* 1, 1952).

Penetrating showers produced locally by non-ionizing radiation were studied using counter techniques. The collision length in water of the non-ionizing component which is capable of producing penetrating showers was found to be (98 ± 13) g/cm^2. Comparison of this collision length with that expected from the geometrical cross-section seems to indicate that the hydrogen nuclei in water have a rather small cross-section for the production of penetrating showers by neutral radiation. Results obtained at two elevations were used to calculate the absorption length in air of the neutral penetrating shower producing component. The absorption length measured, (115 ± 19) g/cm^2, agrees with that obtained by others for the total penetrating shower producing component. A.

537.591.15

7375. The ratio of soft and hard particles in air showers. K. Sitte. *Phys. Rev.*, **87**, 351–7 (*July* 15, 1952).

While the density spectrum of air showers is well established for energies above 10^{13} eV, doubt has recently been cast upon the customary procedure of identifying the energy spectrum of the shower-initiating particles calculated from this density distribution with the primary cosmic-ray spectrum. These two distributions would differ if the mechanism of energy transfer to the electron component itself varied with energy. As a result, one would then expect to find a variation with energy also in the amount and composition of the penetrating component of extensive showers. Previous investigations of penetrating particles in air showers do not extend below 10^{13} eV because of the bias imposed, in the case of low density showers, by the addition of a shielded tray. An experiment was therefore carried out at Mt. Evans, Colorado, altitude 4300 m, and at Echo Lake, Colorado, altitude 3260 m, in order to compare the penetrating components of showers in the 10^{13} eV region and in the 10^{14} eV region at a similar stage of their cascade development. The relative abundance of penetrating particles was $(2{\cdot}06 \pm 0{\cdot}11)\times10^{-2}$ at Mt. Evans, and $(1{\cdot}20 \pm 0{\cdot}11)\times10^{-2}$ at Echo Lake, and the fraction of N-particles among the penetrating component was $(62 \pm 7)\%$ for the lower, and $(38 \pm 6)\%$ for the higher shower energies. The ratio of μ-mesons to electrons was the same for both energy ranges. The results are therefore consistent with the assumption that the development of the large mixed cascades in air is based on the same processes for all energies above 10^{13} eV, demanding only a slight increase in the multiplicity of meson production with increasing primary energy. A.

537.591.15

7376. On the study of the penetrating burst at high altitude. S. Ozaki, S. Fukui and T. Kitamura. *J. Phys. Soc. Japan*, **7**, 344–7 (*July–Aug.*, 1952).

The penetrating bursts under the thick Pb plate were studied by a fast ionization chamber at 2740 m altitude. The bursts are classified with respect to the number of secondary particles which penetrate 7 cm Pb under the chamber. The bursts containing one or no penetrating secondary particle are interpreted mainly as the nuclear stars produced in the wall of the ionization chamber. Most of the cases in which the bursts contain two or more penetrating particles are explained as electronic shower accompanied by hard shower. For these events it is plausible to take into account the γ-decay of the neutral meson. A.

537.591.15

7377. Electron-nuclear and extensive atmospheric showers in cosmic radiation. Yu. V. Anishchenko, G. T. Zatsepin, I. L. Rozental and L. I. Sarycheva. *Zh. Eksper. Teor. Fiz.*, **22**, 143–51 (*No.* 2, 1952) *In Russian.*

A study by means of systems of counters and Pb and C filters at 3860 m of the properties of such showers (energy $\sim10^{11}$ eV), especially their frequencies as function of the flux density of shower particles and of their spatial density distribution. It is concluded that electron-nuclear showers appear also in light elements (C). A correlation of their flux density with the electron flux is found. Their space distribution is relatively narrow. W. J. SWIATECKI

537.591.15

7378. Angular association of particles in penetrating showers. M. G. E. Cosyns. *Bull. Cent. Phys. Nucléaire Bruxelles, No.* 18, 5 *pp.* (*Sept.*, 1950) *In French.*

The angular distribution of 157 shower particles

observed in nuclear emulsions exposed at 2900 m has been examined and it is concluded that the number of closely grouped tracks is greater than would be expected for a random distribution. Showers with more than 5 particles only were considered and it is shown that the effect becomes more marked as the number of shower particles increases. It is concluded that the results can be explained by secondary collision processes. See also Abstr. 6715 (1952).

H. ELLIOT

537.591.8

7379. The angular distribution of the energy of the secondary radiation produced by primary cosmic ray particles. S. N. VERNOV, A. M. KULIKOV AND E. L. FEĬNBERG. *Dokl. Akad. Nauk SSSR*, **80**, 871–4 (*No.* 6, 1951) *In Russian.*

From the observed angular distribution of cosmic-ray particles at various altitudes one can calculate the angular distribution of the secondary energy with respect to a given primary. Most of the energy is found to be within 20–30° of the forward direction.

W. J. SWIATECKI

537.591.8

7380. Collision of heavy primary cosmic-ray nucleus. N. L. ALLEN, J. Y. MEI, E. PICKUP AND L. VOYVODIC. Letter in *Phys. Rev.*, **86**, 1045–6 (*June* 15, 1952).

Discusses an event observed in nuclear emulsion at 85 000 ft which is believed to be a collision between an incoming primary nucleus of $Z = 17 \pm 3$ with a nucleus of either C, N or O. 45 singly charged particles ionizing near minimum were produced together with a relativistic α-particle. Particles identified include 5 π-mesons, 1 proton and a possible κ-meson.

H. ELLIOT

537.591.8

7381. A possible charged *V*-particle or kappa-meson event observed in a photographic emulsion. L. VOYVODIC. Letter in *Phys. Rev.*, **86**, 1046 (*June* 15, 1952).

One of the tracks associated with the nuclear disintegration referred to in the preceding abstract shows a sharp change in direction of 20°. It is suggested that this track could be due to a κ-meson which has been scattered or to a *V*-particle decaying into a τ-meson and one or more neutral particles.

H. ELLIOT

537.591.8

7382. Nuclear interactions of great energy. I. Evidence for the creation of heavy mesons. R. R. DANIEL, J. H. DAVIES, J. H. MULVEY AND D. H. PERKINS. *Phil. Mag.*, **43**, 753–74 (*July*, 1952).

The masses of charged mesons, produced among the "shower" particles in the nuclear interactions of protons of great energy have been determined by scattering and grain-density measurements. For energies greater than 50 BeV heavy mesons of mean mass $\sim 1300\, m_e$, provisionally identified as κ-mesons, are produced with a frequency comparable with that of the π-mesons. Evidence for the creation of such heavy mesons is also provided by an observed decrease in the ratio of neutral π-mesons to shower particles at very high energies. A method is described for measuring the lifetime of the neutral π-meson, which takes advantage of the existence of an alternative mode of decay: $\pi^0 \rightarrow \gamma + \beta^+ + \beta^-$. It is shown that the proportion of π-mesons which decay in this second mode is not greater than 4%. The preliminary observations suggest that the mean lifetime is about 10^{-14} sec.

A.

537.591.8

7383. An example of multiple meson production. W. BOSLEY AND H. MUIRHEAD. *Phil. Mag.*, **43**, 783–9 (*July*, 1952).

A description is given of an event, found in a nuclear emulsion exposed to the cosmic radiation, in which two π-mesons and a proton or deuteron are the only particles observed. Reactions which could produce this event are discussed.

A.

537.591.8

7384. An anticoincidence experiment on cosmic rays at a depth of 50 metres water equivalent. E. AMALDI, C. CASTAGNOLI, S. SCIUTI AND A. GIGLI. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 556–8 (*July*, 1952).

It is shown that the number of neutral particles underground which are capable of producing penetrating secondaries appears to be too small to be consistent with Hayakawa's suggestion that the anomalous interactions observed underground are due to κ-mesons [Abstr. 3688 (1952)].

H. ELLIOT

537.591.8

7385. High energy nuclear interactions in lead. F. E. FROEHLICH, E. M. HARTH AND K. SITTE. *Phys. Rev.*, **87**, 504–16 (*Aug.* 1, 1952).

In an attempt to study details of cosmic-ray nuclear interactions a large cloud chamber containing 8 ½-in Pb plates was operated in conjunction with a 134-counter hodoscope placed directly below the chamber, at Echo Lake, Colorado (altitude, 3260 m) and at Syracuse, New York (altitude, 220 m). Showers produced in the chamber were detected by counter trays above and below the chamber, producing a masterpulse which triggered both the chamber and the hodoscope. It was then possible to follow in the hodoscope the further development of the nuclear cascade started in the chamber, and to study for each event both the individual features of the interaction from the cloud-chamber photograph, and, at least statistically, the properties of the secondaries from the hodoscope record. In particular, the "integral path length" of the nuclear cascade in the approximately 600 g/cm² Pb absorber of the hodoscope, is a measure of the energy of the primary particle. It is concluded that most of the primaries recorded had energies between 1 and 10 BeV. The analysis of about 400 shower pictures shows no appreciable difference between the events observed at the two locations. Both show a variation of the primary mean free path from about 190 g/cm² to 160 g/cm² over the energy interval covered. The statistics are not good enough to decide whether the mean free path of the secondaries also varies with the primary energy; a mean value of 250 g/cm² was observed. The ratio of the number of charged mesons to the number of protons increases from about 0·4 to 2·1, while the ratio of neutral to charged mesons is found to be $0{\cdot}55 \pm 0{\cdot}1$ for low multiplicities, and its lower limit for higher multiplicities is $0{\cdot}36 \pm 0{\cdot}1$. A distribution function was derived for the total shower multiplicities as a function of the primary energy. For low

primary energies, small multiplicities are favoured; but with increasing primary energy the distribution function becomes rather flat. The primary energy spectrum found agrees satisfactorily with the observations of other authors. A.

537.591.8 : 539.172

7386. A note on Janossy's mathematical model of a nucleon cascade. A. RAMAKRISHNAN. *Proc. Camb. Phil. Soc.*, **48**, 451–6 (*Pt* 3, 1952).

Describes the use of a new technique [Abstr. 15 (1951)] to calculate the energy distribution in nucleon cascades and its variation with time. N. L. JOHNSON

MAGNETISM 538

538.113

7387. Some comments on the London–Brooks treatment of diamagnetic anisotropy. G. W. WHELAND AND S. L. MATLOW. *Proc. Nat. Acad. Sci.* [*Wash.*] **38**, 364–71 (*April*, 1952).

London's approximate treatment of the diamagnetic susceptibility of organic molecules and its modification by Brooks, who included the non-orthogonality integral, are recalled. An important approximation in these calculations is shown to be invalid by actual calculations for the CO_3 ion, and a modified treatment is given. A comparative table giving anisotropy values based on the three approximations and including experimental data is shown. In some cases the predicted anisotropy is zero on the basis of the London-Brooks calculations, but finite with the reported treatment (in agreement with observation for CO_3 ion), data for other substances (e.g. butadiene and allyl radical) not being available. E. P. WOHLFARTH

538.114

7388. Antiferromagnetic arrangements in ferrites. Y. YAFET AND C. KITTEL. *Phys. Rev.*, **87**, 290–4 (*July*, 1952).

The molecular field treatment of the magnetic properties of ferrites given by Néel is extended to take into account the antiferromagnetic exchange interactions within the two magnetic sublattices. On further subdividing the two lattices, it is shown that the ground state may (1) have an anti-parallel arrangement of the spins on the two sites; or (2) consist of a triangular arrangement of the spins on the sublattices; or (3) have antiferromagnetism in each of the two sites separately. It is also shown that transitions between various configurations may occur in the same substance at different temperatures, without the assumption of temperature-dependent interactions. Neutron diffraction experiments and specific heat measurements are suggested for the detection of the predicted arrangements. A.

538.114.

7389. New contributions to the problem of magnetic transformations. F. FRAUNBERGER. *Z. Phys.*, **132**, 212–20 (*No.* 2, 1952) *In German.*

It is shown by an analysis of experimental results (high frequency resistance, magnetization, susceptibility, specific heat, magnetocaloric effect) that the magnetic transformation (in nickel) takes place in several steps. Thus the curve giving the magnetocaloric effect shows apparently a change of slope at 200°C; the author notes that this is close to the Debye temperature. Anomalous magnetic effects close to the Curie point are recalled. E. P. WOHLFARTH

538.114 : 536.48

7390. Anti-ferromagnetism at the absolute zero of temperature in the case of rhombic symmetry. C. J. GORTER AND J. HAANTJES. *Physica*, **18**, 285–94 (*May*, 1952).

Néel's phenomenological theory of anti-ferromagnetism is worked out for the absolute zero of temperature and rhombic crystalline anisotropy. The mathematical formalism describes the threshold phenomena in relatively weak fields as well as the disappearance of anti-ferromagnetic behaviour in strong fields. A rather anomalous threshold phenomenon is predicted when the applied field is orientated in the co-ordinate plane through the most favourable and the most unfavourable direction of magnetization. A.

538.221/.222

7391. Magnetic properties of nickel–lanthanum alloys. J. WUCHER. *J. Phys. Radium*, **13**, 278–82 (*May*, 1952) *In French.*

The two metals form solid solutions up to 9% La, the Curie temperature decreasing linearly up to this concentration and extrapolating to zero at 20% La, but remaining constant at about 350°K above 9% La. Paramagnetic measurements on several intermetallic compounds ($Ni_\nu La$, $\nu = 5 - 1$; $NiLa_3$) are also reported and the moment of the Ni ions deduced from the measurements where possible. E. P. WOHLFARTH

538.221

7392. Nuclear magnetic resonance in an anti-ferromagnetic single crystal. II. N. J. POULIS AND G. E. G. HARDEMAN. *Physica*, **18**, 315–28 (*May*, 1952).

For Pt I, see Abstr. 5899 (1952). The decomposition of the proton magnetic resonance line in an anti-ferromagnetic single crystal of $CuCl_2 . 2H_2O$ in different magnetic fields in the transition region is discussed. With different orientations of fields of 4170 ø and 5970 ø in the *ab*-plane of the crystal the resonance diagrams are perturbed sine functions with periods of 360°. The perturbation is more pronounced in stronger fields. In a field of 7460 ø the transition of a perturbed sine function with a period of 360° into one with a period of 180° is studied as a function of temperature. A.

538.221

7393. Magnetic measurements on iron amalgams. The problem of ferromagnetism and particle size. A. MAYER AND E. VOGT. *Z. Naturforsch.*, **7a**, 334–40 (*May*, 1952) *In German.*

The coercivity of newly prepared amalgams is small but may be raised to a maximum of about 250 oersted by a heat treatment of critical duration. Further ageing reduces the coercivity again. The corresponding changes of the spontaneous magnetization at different temperatures were also investigated. The results are interpreted on the basis of "small particle theory." Particle sizes below the upper and above and below the lower critical value were observed. E. P. WOHLFARTH

538.221

7394. Ferromagnetic resonance in copper ferrite. T. Okamura and Y. Kojima. Letter in *Phys. Rev.*, **86**, 1040 (*June* 15, 1952).

Reports measurements on a single crystal between −195°C and the Curie point (470°C) at 24 000 Mc/s. The anisotropy coefficient deduced from the measurements remains negative over the whole temperature range. The g-factor increases with decreasing temperature below room temp. but remains approximately constant at about 2·04 above. For polycrystalline specimens the temperature variation of g and of the line width depends on specimen size.

E. P. WOHLFARTH

538.221 : 538.245

7395. Magnetic investigation of a single crystal of pyrrhotite at low temperatures. R. Pauthenet. *C.R. Acad. Sci.* [*Paris*] **234**, 2261–3 (*June* 4, 1952) *In French.*

Repeats early measurements by Weiss on the temperature variation of magnetization in the basal plane and describes new measurements on the variation along the axis of difficult magnetization perpendicular to this plane. Here the magnetic moment is small and linearly dependent on field at room temp., but increases to a maximum value of 5–6 e.m.u. at 50°K, so that the crystal seems to become ferromagnetic along the axis of difficult magnetization at low temperatures.

E. P. WOHLFARTH

538.221 : 621.318.12

7396. Magnetic structure of Alnico 5. E. A. Nesbitt and R. D. Heidenreich. *Elect. Engng* [*N.Y.*] **71**, 530–4 (*June*, 1952).

Electron micrographs of single crystal surfaces of Alnico 5 indicate that when the alloy has been cooled so as to have optimum properties, a second phase is precipitated and that, when a magnetic field is applied during cooling, the precipitate is in the form of thin rods parallel to the field direction and spaced about 200 Å apart. The magnetic properties of the alloy must therefore be explained in terms of rotational processes in single domains. Magnetic torque measurements give an anisotropy constant $K_1 = -1{\cdot}59 \times 10^5$ ergs cm^{-3} so that both magnetic anisotropy and shape anisotropy of the single-domain particles are required to explain the large values of coercive force observed.

A. E. DE BARR (R)

538.222

7397. A magnetic effect in magnesium titanate. E. K. Weise and H. Katz. Letter in *Phys. Rev.*, **86**, 1046 (*June* 15, 1952).

On slightly changing the oxygen content of $MgTi_2O_5$ the susceptibility was found to increase to a pronounced maximum at 0·2% removed oxygen. This effect was not observed with $MgTiO_3$ and Mg_2TiO_4, whose susceptibility increases smoothly with a decrease of oxygen content.

E. P. WOHLFARTH

538.222

7398. Paramagnetic properties of some rare earth hexaborides. R. Benoit and P. Blum. *C.R. Acad. Sci.* [*Paris*] **234**, 2428–30 (*June* 16, 1952) *In French.*

Reports susceptibility measurements on RB_6 between 0° and 1000°C. For R = Y, La, the magnetic moment is zero. For R = Ce, Nd, Gd, Yb the Curie–Weiss law is obeyed between 350° and 760°C, giving $p_B = 2{\cdot}91$, 3·82, 7·63, 4·58 respectively. Below 350°C deviations from linearity of $1/\chi$ are stated to be due to ferromagnetic iron boride impurities. Above 760°C deviations for R = Nd, Ce are due to the small multiplet interval. Use of Van Vleck's formula ($\sigma \simeq 31$) reproduces the observed variation in this range.

E. P. WOHLFARTH

538.222

7399. Paramagnetic resonance in ferric rubidium sulphate alum. B. Bleaney and R. S. Trenam. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 560–1 (*July*, 1952).

For this salt high spectral resolution may be obtained. The cubic axes of the ferric ion are rotated by 7½° about the trigonal axis. The Hamiltonian used to interpret the splitting of the spectrum into 5 lines contains a term Y^0 corresponding to trigonal symmetry. Using empirical values of the parameters (e.g. $g = 2{\cdot}004$ at 20° and 90°K) the observed and calculated splitting are in good agreement.

E. P. WOHLFARTH

538.222

7400. Paramagnetic resonance of manganese activated zinc orthosilicates. E. G. Spencer, M. A. Garstens, C. C. Klick and J. H. Schulman. Letter in *J. Chem. Phys.*, **20**, 1177–8 (*July*, 1952).

A study of the line width as function of the Mn concentration indicates that the Mn ions tend to cluster. At high concentrations the ions cluster close enough to allow narrowing of the line by exchange forces.

L. PINCHERLE

538.222

7401. Paramagnetic resonance in the nickel Tutton salts. J. H. E. Griffiths and J. Owen. *Proc. Roy. Soc. A*, **213**, 459–72 (*July* 22, 1952).

The paramagnetic resonance spectra of 5 Ni Tutton salts have been analysed at 290°K. The positions and intensities of the absorption lines are adequately explained by a crystalline electric field of rhombic symmetry. The triplet ground state is resolved into 3 singlets with an overall splitting of the order of 3 cm^{-1}, and the spectroscopic splitting factor g is found to be $2{\cdot}25 \pm 0{\cdot}05$. A comparison is made between the directly measured values of the magnetic anisotropy, and the values calculated using the resonance results.

A.

538.222

7402. Magnetic susceptibility of chrome alums at low temperatures. G. P. Khutsishvili. Letter in *Zh. Eksper. Teor. Fiz.*, **22**, 383–4 (*No.* 3, 1952) *In Russian.*

The susceptibility of chrome alums is calculated theoretically allowing fully for the Stark effect of the crystalline field and to a first approximation for the spin-spin interaction. The discrepancy between the result of the calculation and the experimental data is attributed to the change in the lattice structure known to occur at about 80°K (the calculations assume the room-temperature structure).

D. SHOENBERG

538.222 : 541.67

7403. Magnetochemistry of the heaviest elements. VI. PuO_2–ThO_2 and PuF_4–ThF_4 solid solutions. J. K. Dawson. *J. Chem. Soc.* (1952) 1882–6 (*May*).

For Pt V, see Abstr. 1957 (1952). The magnetic

susceptibilities of plutonium dioxide and tetrafluoride have been measured over the temperature range 90–450°K. The tetrafluoride obeys the Curie–Weiss law above 200°K but there is an upward curvature below that temperature. Measurements on solid solutions of the tetrafluoride in isomorphous thorium tetrafluoride lead to an extrapolated susceptibility at infinite dilution in agreement with a $5f^4$ electron configuration. The susceptibility of the dioxide does not obey the Curie–Weiss law and is considerably lower than that of the tetrafluoride, but dilution in thorium dioxide shows that the susceptibility increases very rapidly between 10 atomic % and infinite dilution. The intercept at infinite dilution appears to be about the value for a $5f^4$ configuration, but some of the evidence may indicate that $6d$ levels are occupied. A.

538.224

7404. Paramagnetic and diamagnetic resonance of conduction electrons. Ya. G. Dorfman. *Dokl. Akad. Nauk SSSR*, **81**, 765–6 (*No.* 5, 1951) *In Russian.*

Diamagnetism is caused by the fact that, in the presence of an external steady magnetic field H, the electrons move in quantized orbits in a plane $\perp$ to H. The diamagnetic resonance is connected with transitions in which n changes by ± 1. For completely free electrons these two different resonances occur with equal frequency: $\nu_p = \nu_d$. J. JACOBS

538.224

7405. Size effects and diamagnetism in finite systems. M. F. M. Osborne and M. C. Steele. Letter in *Phys. Rev.*, **86**, 247 (*April* 15, 1952).

538.24 : 539.67

7406. Internal friction of field-cooled ferromagnetic substance. T. Hirone and N. Kunitomi. *J. Phys. Soc. Japan*, **7**, 364–8 (*July–Aug.*, 1952).

Internal friction of ferromagnetic substance cooled in longitudinal magnetic field is studied both theoretically and experimentally. Two theories are developed on the basis of two different ideas on the elementary magnetizing process. The first theory which assumes that the substance is magnetized by the displacement of 180°-domain boundary leads to the conclusion that internal friction at the demagnetized state must vanish by field-cooling. The second theory assuming that the substance is magnetized by the reversible and irreversible rotation of spontaneous magnetization concludes that internal friction at the demagnetized state must increase appreciably by field-cooling in contrast to the former case. On the other hand, experimental investigation of both field-cooled and commonly annealed substances is carried out for Ni_3Fe. Comparing the experimental and two different theoretical results, the latter theory is known to be more convenient to explain the measured data than the former theory. The magnetic domain structure of field-cooled substance is concluded to be such that the spontaneous magnetization in the substance is fixed to the direction closer to the applied magnetic field than in usually treated substance, and that the magnetizing process is still rotation of spontaneous magnetization from the newly fixed direction. A.

538.245 : 539.378.3

7407. Theory of magnetic viscosity by diffusion. L. Néel. *J. Phys. Radium*, **13**, 249–64 (*May*, 1952) *In French.*

A continuation of earlier theoretical work [Abstr. 4211 (1950); 6314 (1951)]. It is shown that reversible viscosity effects due to diffusion of carbon atoms in iron, etc., are formally equivalent to an increase of the anisotropy energy, the added term, which may be of the order of 100 ergs cm^{-3}, being called the stabilization energy. The time effects of viscosity on the forces on and movement of domain walls and the resulting changes of magnetization are discussed. Several applications are given to the properties of ferromagnetics in discontinuous and sinusoidal fields. Experimental results due to Webb and Ford [*J. Instn Elect. Engrs*, **75**, 787 (1934)] giving the time variation of the a.c. permeability of silicon sheet steels are interpreted on the basis of the theory. E. P. WOHLFARTH

538.248

7408. On the magnetic after effect due to the irreversible displacement of the domain boundary. IV. S. Maeda. *J. Phys. Soc. Japan*, **7**, 369–73 (*July–Aug.*, 1952).

For Pt III, see Abstr. 4475 (1952). The magnetic after-effect in 65-Permalloy under various tensions was observed. In this case the reversal of magnetization occurs in several Barkhausen jumps or a single according to the amount of the applied tension. The value of dB/dH along the descending branch of the hysteresis curve has a very sharp maximum with comparatively narrow breadth. In the cases for small tension, magnetization in the course of after-effect shows almost no change until the time t reaches a critical value t_c, and after t_c changes in the usual manner of the after-effect. The value of t_c decreases with decreasing final field. When the total reversal of magnetization occurs in a single Barkhausen jump, even a slight change in the magnetization cannot be observed until t_c, and the whole reversal takes place in a very short time interval after t_c. These can be interpreted on the assumption that the after-effect is closely related to the irreversible displacement of domain boundaries. A.

538.248 : 539.4.016

7409. Magnetic after effect of cold rolled iron. I–II. Y. Tomono. *J. Phys. Soc. Japan*, **7**, 174–82 (*March–April*, 1952).

In Pt I, the magnetic after-effect of cold-rolled Fe is studied both by semi-static and dynamic measurements. It is verified that the static after-effect in a weak field and the so-called Jordan's constant are not observable in contradiction to Schulze's measurements. But the after-effect is observable in the range of irreversible magnetization. The after-effect of Fe, annealed after being cold rolled, is also investigated. The after-effect in the range of initial permeability becomes observable in a recrystallized state, in agreement with Schulze's results. In addition it is found that the part of loss angles, observed at low frequencies, attributable to the macroscopic eddy currents is larger than the theoretical value. It suggests the existence of a relaxation due to another origin which has not been taken into account

in the analysis of loss angles. Hence, in Pt II, the measurements of apparent permeability at higher frequencies are carried out for the cold-rolled Fe. The time of relaxation in the range of initial permeability is estimated to be of the order of $10^{-6} \sim 10^{-7}$ sec. It satisfactorily explains the difference between loss angles observed and calculated. A.

538.249

7410. The diamagnetic anisotropy of natural and synthetic rubbers. E. W. Toor and P. W. Selwood. *J. Amer. Chem. Soc.*, **74**, 2364–8 (*May* 5, 1952).

The change in anisotropy with elongation has been found for natural rubber and for several synthetic rubbers. Unsaturated rubbers have a large principal susceptibility perpendicular to the direction of stretching, because of the presence of olefinic double bonds. The differences between natural rubber and polybutadiene are attributed to the presence of unsaturated side-groups caused by 1,2-addition in polybutadiene. It is probable that the magnetic anisotropy of these rubbers depends not upon the actual degree of crystallinity of the rubbers, but upon the ability of the long-chain molecules to align themselves parallel to the direction of stretching. Therefore the changes in anisotropy with stretching will be large when there is no cross-linking, and small when cross-linking occurs to any large extent. Saturated rubbers have an anisotropy opposite in sign to that of unsaturated rubbers. This must be caused by the broadening of electronic orbits perpendicular to the direction of stretching. Apparently methyl side-groups cause such a broadening of electronic orbits in polyisobutylenes, an effect much greater than the similar effect in polyethylene. A.

ELECTROMAGNETISM . ELECTRODYNAMICS 538.3/.5

538.55 : 621.391 : 621.392.52

7411. An introduction to the theory of filters and of prediction. A. Colino. *Rev. Cienc. Apl.*, **6**, 1–12 (*Jan.–Feb.*, 1952) *In Spanish.*

A clear review of the application of information theory to the subject, based mainly on physical arguments. L. PINCHERLE

ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.56

7412. Electromagnetic energy density and flux. C. O. Hines. *Canad. J. Phys.*, **30**, 123–9 (*March*, 1952).

Although Poynting's theorem receives general acceptance in the treatment of electromagnetic energy, an alternative theorem, Macdonald's (1902), has equal claim to validity at the present state of our knowledge. In a comparison of many results derived from the two, Macdonald's theorem exhibits sufficient superiority to warrant its consideration more generally in electromagnetics. A.

538.561 : 538.566.2

7413. The damping of electromagnetic oscillations characteristic of the earth-ionosphere system. W. O. Schumann. *Z. Naturforsch.*, **7a**, 250–2 (*March–April*, 1952) *In German.*

Continuation of earlier paper [Abstr. 5204 (1952)] in which approximate formulae are now derived for the damping of electromagnetic waves of frequency corresponding to the natural oscillation frequency of the atmosphere between the earth and the ionosphere. W. J. G. BEYNON

538.565

7414. On the theory of forced oscillations of electrodynamical systems. E. Ledinegg and P. Urban. *Acta Phys. Austriaca*, **5**, 510–28 (*No.* 4, 1952) *In German.*

It is pointed out that expansions in term of eigenfunctions of the wave equation, besides providing a general treatment of the resonance properties, have practical application to several interesting configurations. The paper deals mainly with the case of a cylindrical cavity resonator coupled to concentric Lecher wires. A discussion is also given of the theoretical basis for the development of an e.m. field in terms of vector eigenfunctions; in particular of the integral equation equivalent to curlcurl $E = k^2E$, and of the representation of the Green tensor in terms of the eigenfunctions. L. PINCHERLE

538.565

7415. On the longitudinal waves in an ionized medium (plasma). M. E. Gertsenshteĭn. *Zh. Eksper. Teor. Fiz.*, **22**, 303–9 (*No.* 3, 1952) *In Russian.*

The object of the paper is to investigate the propagation of e.m. waves in an ionized medium, taking into account the thermal motion of the electrons. The paper commences from the derivation of the formula for the dielectric constant, ε, in an isotropic medium, without taking into account the thermal motion, to which the author refers as the Shuleikin formula, $\varepsilon = 1 - \omega_0^2/\omega^2$, where ω is the angular frequency of the waves; $\omega_0 = 4\pi e^2 N/m$ is the angular frequency of the Langmuir motion of the electrons, N is the number of electrons per cm^3, e and m are the charge and the mass of the electron, resp. Recalling that the refraction index equals $\sqrt{\varepsilon}$, it can then easily be found that the transverse e.m. waves are propagated when $\omega > \omega_0$, and are damped when $\omega < \omega_0$. When $\omega = \omega_0$, the displacement current is equal and opposite to the conduction current in the plasma, and as a result the magnetic field disappears. In order to bring into the picture the thermal motion, the author uses the six-dimensional representation of the state of motion of a particle with three co-ordinates representing the position of an electron and three co-ordinates representing its velocity. Assuming that the process is stationary, and that owing to the isotropy of the medium the number of electrons in a given state (the density of electrons at a given point of the six-dimensional space) in the absence of an external field depends only upon their velocity, he writes the six-dimensional continuity equation, which he simplifies by resolving the solution into the sum of a component independent of the external field and a component imposed by it. By neglecting the quadratic terms,

he linearizes the equation thus obtained, and then solves it, thus finding the distribution of the charge and of the currents. The solution shows that the dielectric constant, ε, depends upon the wavelength and upon the direction of the wave propagation. This means an anisotropic dispersion, i.e. the dielectric constant is not a scalar but a tensor, even when the medium is isotropic. It is further shown how this tensor should be calculated for transverse and for longitudinal waves. A special consideration is given to the influence of the Maxwellian velocity deviations. The author considers then the connection between the transverse and longitudinal waves arising from non-linear factors which were omitted in his analysis. He states that the calculation, which is too laborious for inclusion in his paper, shows that the longitudinal waves generated by the transverse waves are small unless $E\lambda$ (where E is the electric field intensity and λ is the wavelength) approaches mc^2/e. He considers briefly the generation of longitudinal waves by transverse waves in an anisotropic plasma, but thinks that this cannot be important owing to the self-elimination of these waves by interference. In conclusion, the fundamental equations are evolved for the wave propagation in non-homogeneous plasma and their implications are considered. N. S. JAPOLSKY

538.566

7416. The wave impedance of free space: an important universal constant. E. HALLEN. *Bull. Soc. Franç. Elect.*, **2** (*Sér.* 7) 377–80 (*June*, 1952) *In French.*

538.566

7417. On solutions of Maxwell's equations in an exterior region. W. K. SAUNDERS. *Proc. Nat. Acad. Sci.* [*Wash.*] **38**, 342–8 (*April*, 1952).

The paper relates to the question of the existence and uniqueness of time-periodic solutions of Maxwell's equations in the space surrounding a surface with set boundary conditions. The author offers a proof for the following two theorems: (1) given an infinite region L surrounding a finite closed smooth surface C with an assigned distribution of vector field $\boldsymbol{E}$ upon it of class C^2 with respect to the surface parameter of C, there exists in region L at most one set of twice continuously differentiable time periodic solutions of Maxwell's equations and the boundary conditions and the condition $\lim_{r\to\infty} r[\boldsymbol{a}_r \times \boldsymbol{H} - \sqrt{(\varepsilon/r)}\boldsymbol{E}] = 0$ (r is the radial co-ordinate; $\boldsymbol{a}_r$ is the unit vector in the radial direction), and (2) there exists in L a solution of the time periodic Maxwell's equations satisfying the boundary and infinity conditions of theorem (1). The analysis is based on the vector analogous of Green's formula set out by H. Weyl. In the author's opinion, the Weyl method, in its initial form, may not always lead to a valid solution of Maxwell's equations, as its scope is much wider, but its further development in Weyl's more recent paper [Abstr. 4331 (1952)] seems to overcome this difficulty. Nevertheless, he prefers to base his proof on the results of Claus Müller's study of the problem of a perfect conductor [*Math. Ann.*, **123**, 345–78 (1951)], as this appears to be simpler. He also considers the possibility of basing his proof on Rellich's theorem (1943) which states that for any solution of the wave equation, twice continuously differentiable in a region outside a given radius ρ_0, the volume integral over a gap between two spheres of radii ρ_1 and ρ_2 $\lim_{r\to\infty} \iiint_{\rho_1<\rho<\rho_2} |\phi|^2 dp \geqslant tr$ where $t > 0$, and upon the corollary of this theorem that such a solution, if it exists at all, must be unique if the Sommerfeld radiation condition $\lim_{r\to\infty} r(\partial\phi/\partial r + ik\phi) = 0$ is satisfied for any direction of $\boldsymbol{r}$ and if the Green theorem is applicable to the distribution of ϕ upon the boundary. The author states the reasons why this basis may be unsuitable for his proof. The apparently implied object of this investigation is to contribute to the problem of finding the solution of Maxwell's equations from the boundary condition, which the author [Thesis, Univ. of Calif. (1951)] and F. H. Murray [*Proc. Nat. Acad. Sci.* [*Wash.*] **16**, 353–7 (1930); *Amer. J. Math.*, **53**, 275–8 (1931)] tried to solve. N. S. JAPOLSKY

538.566 : 778.3 : 621.392.26

7418. Visual observation and photography of waveguide radiation. D. I. PENNER. *Dokl. Akad. Nauk SSSR*, **81**, 819–20 (*No.* 5, 1951) *In Russian.*

After a brief description of pioneer work in this field by Arkadiev in 1934, experimental techniques are described which enable visual observation of electric fields at the throat of waveguides. A Lebedeo vibrator terminating in a spark discharge gap, immersed in paraffin, serves as the generator and is coupled to circular and rectangular waveguides or to dielectric rods, exciting in them decaying waves. The field distribution is made visible by the "quasi-luminescence effect" displayed by metallic powders and filings when placed in the field of Hertzian waves; this was discovered by Arkadiev and Penner. Photographs are shown of electric field distribution of 3 cm waves leaving metal and ebonite waveguides. A. LANDMAN (R

538.56

7419. Diffraction of e.-m. waves at an uneven surface. L. M. BREKHOVSKIKH. *Dokl. Akad. Nauk SSSR*, **81**, 1023–6 (*No.* 6, 1951) *In Russian.*

The author discusses the diffraction phenomena in the reflection of plane e.-m. waves from an uneven surface of a perfect conductor, assuming that th wavelength is small in comparison with the radii o curvature of the surface. He uses for his analysi Cartesian co-ordinates with xz plane coinciding wit the plane of incidence and xy plane coinciding wit an average tangent plane of the surface at the poi of reflection. The analysis is based on the vecto analogous of the Green theorem which is simplifie from the beginning by making use of the Max well equations and of the imposed restriction of the problem and brought into the form $\boldsymbol{E} = (1/4\pi)\iint (ik\boldsymbol{n}\times\boldsymbol{H}\phi + \boldsymbol{n}\,.\,\boldsymbol{E}\ \mathrm{grad}\ \phi)dS$. The integr is extended over the whole surface of reflectio $\phi \equiv [\exp(ikR)]/R$, where k is $2\pi\times$ the wave numb (the magnitude of the wave vector) and R is t distance between the surface element and the poi of the external field to which the left-hand memb relates. By introducing into this equation the usu expressions for the reflected wave at the reflecti

surface, and the equation of the reflecting surface itself represented in the form of double Fourier series, and applying a transformation by means of the Dirac function δ (whose fundamental property is expressed by the formulae $\int f(x)\delta(x-a) = f(a)$, the expressions for the electric field E are obtained, corresponding to the spectral components of the reflected waves in the plane of incidence and in the plane normal to it. It is pointed out that when the unevenness of the surface results in shading parts of it, an additional factor must be introduced, which in the first approximation will be equal to 1 in the lighted parts and to 0 in the shaded parts.

N. S. JAPOLSKY

538.566

7420. Families of circular or "linear" extinction screens of maximum transmission. A generalization. Families of screens simultaneously satisfying a number of conditions. B. DOSSIER. Letter in *J. Phys. Radium*, **13**, 246–7 (*April*, 1952) *In French.*

A theoretical treatment of the diffraction equation is given which makes it possible to express the extinction of a diffracting screen in terms of the total transmission. Curves are shown for different numbers of the "working" series: more than three or four yield practically no improvement. R. A. WEALE

538.566

7421. Diffraction by a semi-infinite metallic sheet. T. B. A. SENIOR. *Proc. Roy. Soc. A*, **213**, 436–58 (*July* 22, 1952).

In spite of the considerable attention which has been focused on diffraction by perfectly conducting structures, little success has so far been achieved when finite conductivity is introduced. It is now shown that with the assumption of suitable boundary conditions, the problem of diffraction at a metal sheet is capable of exact solution. Corresponding to each of two fundamental polatizations, a pair of Wiener–Hopf integral equations is derived from which to determine the electric and "magnetic" currents present in the sheet. One of these equations is subjected to a rigorous solution, and from it the solutions of the other three are deduced by symmetry considerations. Use of the generalized method of steepest descent then serves to determine the diffracted fields. The case of a circularly polarized incident wave is also briefly discussed and a comparison presented between the theoretical and experimental forms of the scattered field; good agreement is obtained. A.

538.566 : 535.43

7422. Multiple scattering of radiation. I. Arbitrary configuration of parallel cylinders, planar configurations, two cylinders. V. TWERSKY. *New York Univ. (Wash. Sq. Coll.) Math. Res. Group, Res. Rep. No. EM-34*, 68 *pp.* (1951).

Starting from the scattering of plane waves by a single cylinder, a solution is obtained for the scattering of waves by an arbitrary configuration of parallel cylinders. This solution is expressed as the incident wave plus the sum of an infinite number of orders of scattering. It is shown that for a planar configuration, provided the spacing of the cylinders is large compared with the wavelength, the multiple scattered contributions are symmetrical with respect to the plane of the cylinders' axes. The problem of the two cylinders and of two bosses is considered in detail.

MATHEMATICAL REVIEWS

538.566 : 621.396.11

7423. Diffraction of electromagnetic waves by a half-plane. B. N. HARDEN. *Proc. Instn Elect. Engrs, Pt III*, **99**, 229–35 (*Sept.*, 1952).

The field of a plane wave diffracted by an obstacle equivalent to a semi-infinite screen has been studied close to the diffracting edge. The experimental intensity and phase values of the field associated with a thin, highly conducting sheet are compared with Sommerfeld's rigorous solution for an infinitely thin, perfectly conducting half-plane. Further experimental values show the effect on the diffraction pattern of increasing the thickness and decreasing the conductivity of the sheet. A.

538.566 : 621.396.671

7424. On the solutions of the integral equation relating to the boundary (diffractional) problems of electrodynamics. N. V. ZERNOV. *Zh. Tekh. Fiz.*, **21**, 766–71 (*No.* 7, 1951) *In Russian.*

The author discusses the solution of an integral equation of the First Kind, to which a plane or an axially symmetrical diffraction problem (an "edge problem") can be reduced in many cases. This integral equation has the form

$$\int_{-l}^{l} \phi(\xi)[K_1(\xi, x) + K(\xi, x)]d\xi = f(x)$$

where K_1 has a logarithmic singularity at $\xi = x$, K is continuous and regular, and f is regular, function within the limits of integration. The author shows how this equation, hitherto applicable only to narrow slits, could also be used for a wide slit. He applies this solution to an aerial formed by an infinitely long slit at the end of a plane waveguide. The final result is expressed in the form of an infinite series.

N. S. JAPOLSKY

538.566

7425. Completeness relations for loss-free microwave junctions. T. TEICHMANN. *J. Appl. Phys.*, **23**, 701–10 (*July*, 1952).

Using a method which is the electromagnetic analogue of the scattering matrix formalism in the theory of nuclear reactions, two "sum rules" are derived for the frequency-independent coefficients occurring in the admittance matrix relating the currents and voltages in a loss-free microwave junction. These are sums, respectively, over the various modes of the guides entering the junction, and over the modes of the cavity comprising the junction (suitably defined). The results are used to estimate the effect on the admittance matrix of the higher modes, both of the guides and of the junction proper. A.

538.566 : 621.392.26

7426. Dielectric image line. D. D. KING. Letter in *J. Appl. Phys.*, **23**, 699–700 (*June*, 1952).

Note on a modification of the dielectric waveguide employing a half-round rod and an image plane. A polystyrene image line of 0·42 cm cross-section for use at $\lambda_0 = 1{\cdot}23$ cm and mounted on a dural image

surface 20 cm wide was used as a resonator, the attenuation of the line was found to be 31·5 db/100 ft.

Z. F. WOJNAR

538.566 : 621.385.833

7427. Lens networks for centimetric waves. J. MOUSSIEGT. *C.R. Acad. Sci.* [*Paris*] **234**, 2178–9 (*May* 26, 1952) *In French.*

Describes a centimetric lens, operating on the Bragg reflection principle, constituted of metal particles arranged according to a given theoretical law. Fewer particles are needed than for a normal artificial dielectric lens.

G. D. SIMS

538.566 : 621.392.26 : 621.396.671

7428. Experimental results relating to a lens network for centimetric waves. J. MOUSSIEGT. *C.R. Acad. Sci.* [*Paris*] **234**, 2263–5 (*June* 4, 1952) *In French.*

Constructional details of a lens described previously (preceding abstract) are given together with a description of the experimental verification of the design formula. A gain of 42 with respect to an isotropic source was obtained when the lens was illumined by 3 cm radiation from a slot in the end-plate of a closed waveguide. The gain could be improved if the paraxial space were better employed than in the lens described.

G. D. SIMS

538.566 : 621.392.26 : 621.396.671

7429. The theory of the "slit aerial" in a circular waveguide. M. L. LEVIN. *Zh. Tekh. Fiz.*, **21**, 772–86 (*No.* 7, 1951) *In Russian.*

This paper closely relates to the articles by Pistoljkors [*Zh. Tekh. Fiz.*, **17**, 365, 377 (1947) and by the author himself, *Izv. Akad. Nauk SSSR, Ser. Fiz.*, **12** (*No.* 3, 1948)]. In the analysis of the phenomena in infinitely long circular waveguides with longitudinal slots, it is assumed that the electric field in it lies in angular planes (i.e. the waves are the "*H*-waves") and that it is non-rotating. The field is resolved into Fourier series with respect to the azimuthal co-ordinate ϕ and the wave equation for the magnetic vector potential is written in the usual way. The solution of this equation for each harmonic of this series is found in the form of the Fourier integral with respect to the axial co-ordinate with an integrand, $B(h)\,H_n(\kappa r)$, where h is fully determined by the wavelength, κ depends on the frequency and the axial wavelength, r is the radial co-ordinate and H_n is the Hankel function of the same order n as the order of the harmonics with respect to ϕ. The function $B(h)$ is then found in the usual way from the boundary conditions upon the surface of the waveguide. From the expression for the magnetic vector potential thus found, the Poynting vector for each harmonic and the total energy flux, W, is determined. The "external conductivity" $\delta_t = 2W/V_0^2$, V_0 being an arbitrarily chosen field intensity, is then defined. This enables the length of the slits to be determined corresponding to the resonance conditions ("matching the waveguide"), at which the radiation from the slits is maximum. A case of two diametrically opposite slits is also considered. The e.m. field inside the guide is specially discussed. Lastly, the case of transverse slits is discussed. In this case the electric field will not be purely longitudinal.

N. S. JAPOLSKY

538.566 : 621.396.671

7430. On the derivation of the fundamental equation of the theory of the "slit aerial." M. L. LEVIN. *Zh. Tekh. Fiz.*, **21**, 787–94 (*No.* 7, 1951) *In Russian.*

An attempt to show the complete analogy between the theories of a thin wire aerial and of the "slit aerial," both as regards the formal structure of the final equations and the method of their derivation. In both cases the field is assumed to be harmonic in time. Regarding the wire aerial of any cross-section, it is shown from the conditions near the surface that owing to the smallness of the transverse dimensions the current at any point on the surface can be expressed in the form of a product of a function of the axial co-ordinate and a function of the azimuthal co-ordinate. From this an expression of the vector potential, A, of the aerial currents can be derived for any point of the surrounding field, in the usual way, by integrating over the surface of the aerial, taking into account the phase retardation at a distance. The integral is evaluated by means of an approximate formula and from this an approximate expression for the electric vector E is found by means of formula $E = (1/ik)(\nabla \operatorname{div} + k^2)A$ ($k \equiv \omega/c$; ω is the angular frequency). This result can also be applied to a metal tape aerial by approximating the cross-section of the tape to a very elongated ellipse. The phenomena in a slit aerial are approached by expressing the alternating magneto-motive forces as a system of the "magnetic currents," defining the latter as time derivatives of magnetization vectors $(B - H)/4\pi$.

N. S. JAPOLSKY

538.566 : 621.396.67

7431. The "slit aerial" with a directing device. M. L. LEVIN. *Zh. Tekh. Fiz.*, **21**, 795–801 (*No.* 7, 1951) *In Russian.*

By applying the analogy between the electric current and the time derivative of the magnetization vector $(B - H)/4\pi$ (preceding abstract), the radiation from a slotted screen and a slotted cylindrical waveguide with a resonating "passive dipole" having a directing influence upon the waves, is analysed. The results obtained for the slotted screen are analogous to the formulae for the wire aerial.

N. S. JAPOLSKY

538.566 : 621.396.67

7432. Advanced antenna theory. S. A. SCHELKUNOFF. *New York, John Wiley and Sons; London, Chapman and Hall* (1952) 205 *pp.*

Spherical waves are studied in detail, and the theory developed is applied to conical transmission lines. The greater part of the book is concerned with aerials formed from parts of spheres or spheroids, or which can be considered to be derived from such shapes by perturbation methods. A detailed theory of thin symmetric biconical aerials is derived. Theories are developed for the symmetric spherical, the general angle conical, and both prolate and oblate spheroidal aerials. A chapter is devoted to the study of integral equations. Their resemblance to Kirchhoff's network equations is commented upon. The theory of hollow cylindrical aerials is based on Hallén's

method, and the associated expansions derived by various authors are compared. A theory of natural oscillations is applied to thin wires, and a critical survey is given of the previous work in this field. Tables give the inverse radiation impedance of thin cones, the mutual impedance of the arms of thin biconical aerials, the inverse radiation impedance of thin conical aerials for various angles between the cones, and auxiliary functions for cylindrical and tapered aerials. In each case tabulation is for l/λ from 0–1·0 in 0·01 steps. W. T. BLACKBAND

538.566.3

7433. On the origin of the third ionospheric echo. R. B. BANERJI. *Indian J. Phys.*, **26**, 28–37 (*Jan.*, 1952).

There is still some difference of opinion regarding the ray, ordinary or extraordinary, to which the so-called third or *Z*-component of the ionospheric echoes correspond. It is pointed out that there need be no controversy on the subject because, as first clearly shown by Bhar, the branch of the dispersion curve which passes through the "point" of reflection of the *Z*-component is really an ordinary branch. Calculations are further carried out to determine the retardation that the extraordinary ray would suffer, if it were able to partially penetrate its first point of reflection, in its passage into regions of higher electronic densities. It is found that the retardation on reaching the asymptote of the dispersion curve would become infinite, so that the extraordinary ray, under no circumstances, is able to penetrate the barrier. One is thus forced to the alternative that it is the ordinary ray which provides the *Z*-component in the ionospheric echo pattern. A.

MAGNETIC EFFECTS 538.6

538.613 : 538.567

7434. Microwave Faraday rotation in liquid oxygen. F. F. ROBERTS. Letter in *Proc. Phys. Soc.* [*Lond.*] *B*, **65**, 460 (*June*, 1952).

The measured rotation at 10^{10} c/s is less than 0·2% of that estimated theoretically with neglect of damping. The strong damping in liquid oxygen is ascribed to molecular collision broadening of the inherent molecular magnetic resonance at 6×10^{10} c/s. F. F. ROBERTS

538.632

7435. The Hall effect in iron and nickel at low temperatures. J.-P. JAN AND H. M. GIJSMAN. *Physica*, **18**, 339–55 (*May*, 1952) *In French.*

The Hall effect in Fe and Ni was measured at temperatures of 14, 20, 64, 83 and 293°K. The Hall electric field per unit current density has been plotted as function of the magnetic induction in the sample. The "extraordinary" Hall constant was calculated for both metals; for Ni, the "ordinary" Hall constant as well as the field parameter (equal to 2 for low temperatures) were determined. Experiment has shown that a new parameter, the transversal galvanomagnetic conductivity, which necessitates the knowledge of resistivity, presents a temperature variation simpler than the classical Hall constant. A.

538.632

7436. The Hall effect in single crystals of barium oxide. E. M. PELL. *Phys. Rev.*, **87**, 457–61 (*Aug.* 1, 1952).

The Hall effect has been measured as a function of temperature, between 400°K and 800°K, in single crystals of BaO using an a.c. system. Conduction was predominantly *N*-type. The value of $(\mu_e^2-\mu_h^2)/(\mu_e+\mu_h)$ was about 3 cm²/volt sec between 600°K and 700°K and varied only slightly with temperature over the entire range studied. μ_e is thought to lie between 3 and 9 cm²/volt sec. There was some evidence that conduction was intrinsic at the higher temperatures in the samples studied. A.

538.653 : 539.389.2

7437. Magnetic properties, internal strains and the Bauschinger effect in metals. D. V. WILSON. Letter in *Nature* [*Lond.*], **170**, 30–1 (*July* 5, 1952).

Further discussion [see also Abstr. 1139 (1952)] of what is called work softening in metals on the basis of ideas regarding textural stress patterns and the influence on these patterns of dislocation loops surrounding particles of precipitate. E. P. WOHLFARTH

538.69

7438. The behaviour of ferromagnetic particles in an alternating magnetic field. K. V. DESOYER. *Acta Phys. Austriaca*, **5**, 429–34 (*No.* 4, 1952) *In German.*

Reports experiments on the Ehrenhaft effect. Suspended particles (10^{-4}–10^{-2} cm) under the action of an intense light beam and a parallel 50 c/s magnetic field were found visually to perform circular motion around the common axis. The particles are believed to behave like single magnetic poles. The effects of changes of light intensity and of the focal point of the light concentrating base system were investigated. E. P. WOHLFARTH

538.69

7439. Movement of particles in the field of an electromagnet. F. STOCKINGER. *Acta Phys. Austriaca*, **5**, 440–8 (*No.* 4, 1952) *In German.*

Two different effects were observed photographically with particles (10^{-4} — 10^{-2} cm) in fields up to 3×10^4 oersted. (1) Particles introduced into the air gap through a vertical channel through the upper pole piece perform regular screwlike motion around the field direction; (2) Particles at rest on the lower pole piece are made to jump to the upper pole piece by switching on the field. The causes of these effects are discussed. E. P. WOHLFARTH

MOLECULAR AND ATOMIC STRUCTURE 539.1

THEORY OF SOLID STATE 539.11

539.11 : 548.7

7440. Quantum mechanics of the body-centred cubic transition metals. K. GANZHORN. Note in *Z. Naturforsch.*, **7a**, 291–2 (*March–April*, 1952) *In German.*

The note presents a group-theoretical argument to

account for the occurrence of body-centred cubic structures among the transition metals from titanium to iron. P. T. LANDSBERG

539.11

7441. Statistical theory of rotational phase transition. I. T. Oguchi and Y. Takagi. *J. Phys. Soc. Japan*, **7**, 145–52 (*March–April*, 1952).

The rotational phase transition is discussed along the line of Kikuchi's method for order-disorder transformation in binary alloys. The potential energy for a pair of neighbouring molecules are $-J/2 \cos(i,j)$, where (i,j) is the angle between neighbouring molecular axes and J is the constant. The transition point $J/2kT_c$, that is a branching point of the integral equation, is 1·150 in the case of two-dimensional square lattice. This value is the lowest compared with those obtained by other theories. The discontinuity of the specific heat at the transition point is calculated, though some assumption has to be made to avoid the complexity of the calculation. The transition point does not vary even when an anisotropic potential is introduced. A.

539.11

7442. The experimental determination of the distance between two interacting electrons. R. Forrer. Letter in *J. Phys. Radium*, **13**, 242–3 (*April*, 1952) *In French.*

The mechanism of the electron interaction which accounts for the existence of a solid crystalline state is partly explained by the mutual penetration of electron shells to a very precise distance. The identity of elementary interactions makes it possible to calculate the distance between two electrons at the instant of interaction. From considerations of lattice structures of various compounds and alloys this distance is found to be twice the Compton wavelength, $0{\cdot}0485_2$ Å.

C. A. HOGARTH

539.11

7443. On a new type of interionic force. A. Herpin. Letter in *J. Phys. Radium*, **13**, 243 (*April*, 1952) *In French.*

Interionic forces and stresses caused by the addition of ions or defects to a lattice array are considered. For solids of predominantly ionic character such as NaCl or MgO, deviations from Cauchy's relations may be explained by the coupling between a disturbed ion and the resultant field from the displacement of its neighbours. C. A. HOGARTH

539.11

7444. Factors affecting the choice between cubical and hexagonal close packing. J. A. Prins, J. M. Dumoré and I. E. Tiamtjoan. *Physica*, **18**, 307–14 (*May*, 1952).

It is shown that the lattice energy arising from pure London forces is lower for the hexagonal than for the cubical packing. The difference subsists with the same sign, though with different magnitude, when the lattice is compressed or extended about 10% in the trigonal direction. To explain the preference of most inert gases for the cubical packing a different reason must be looked for, perhaps some difference in entropy or non-spherical symmetry due to the 8-electron shell structure. Both effects are shown to be possible in the configuration of the first neighbours. A.

539.11

7445. Energy of a Bloch wall on the band picture. II. Perturbation approach. C. Herring. *Phys. Rev.*, **87**, 60–70 (*July* 1, 1952).

For Pt I, see Abstr. 4501 (1952). The "exchange stiffness" constant, which appears in the theory of the Bloch interdomain wall in ferromagnetics, can be calculated by computing the response of a saturated specimen to a small spatially varying perturbing field. This calculation is carried out here in the self-consistent field approximation, using running waves for the one-electron states, and the result is interpreted physically in terms of precession of the spins of moving electrons. Combination of the present theory with the Stoner–Wohlfarth model of the ferromagnetic electrons in nickel does not give satisfactory results, probably because the latter model does not approximate the actual self-consistent field solution very well. However, application of the theory to the free electron gas is of interest as a confirmation of the validity of the perturbation approach. It is shown that there exist, even in a ferromagnetic metal, quantum states orthogonal to all the low-lying states of the conventional band picture and having the properties of spin waves. The presumably universal relation between the exchange stiffness constant and the energies of spin waves of long wavelength is verified in the present approximation. It is shown that spin waves carry a current in a metal, though not in an insulator. For spin waves of long wavelength the present theory can be shown to include Slater's theory of spin waves in a ferromagnetic insulator, and *a fortiori* to include all previous theories based on the atomic model. A.

539.11

7446. Crystal structures and intermolecular forces of rare gases. T. Kihara and S. Koba. *J. Phys. Soc. Japan*, **7**, 348–51 (*July–Aug.*, 1952).

By means of models of intermolecular potential $U(r)$, the total energy of molecular crystals is calculated provided the additivity of intermolecular forces is valid. If the Lennard-Jones model, $U(r) = U_0(s-6)^{-1}[6(r_0/r)^s - s(r_0/r)^6]$, is used, the lattice of hexagonal closest packing has always a lower energy than that of cubic closest packing. If the model $U(r) = U_0(\sigma-6)^{-1}[6\exp(\sigma - \sigma r/r_0) - \sigma(r_0/r)^6]$ is used, there is a critical value of σ, $\sigma_0 = 8{\cdot}675$, above which the hexagonal is stable and below which the cubic is stable. In general, in order that the cubic structure may have a lower energy as in the case of rare gases, it is necessary (although not sufficient) that the hollow part of the intermolecular potential be wide enough, much wider than that of $U(r) = U_0[r_0/r)^{12} - 2(r_0/r)^6]$ for instance. These results are in agreement with the conclusions which Kihara has obtained by investigating the 3rd virial coefficients of the equation of state for rare gases. A.

539.11

7447. Variational methods for periodic lattices W. Kohn. *Phys. Rev.*, **87**, 472–81 (*Aug.* 1, 1952).

The problem of finding the propagating solutions of the Schrödinger equation in periodic lattices i

formulated as a variational principle. This may be used as a starting point to establish the general properties of bands. Furthermore it is shown that by introducing various approximations into the variational principle, the chief existing approximation methods can all be derived from it. Improvements of these methods are suggested. Numerical illustrations are presented and the possibilities of the variational method for more accurate calculations of the energy bands of solids are discussed. A.

MOLECULAR STRUCTURE 539.13

539.13

7448. Evidence for intramolecular attraction between hydroxyl and carbonyl oxygen atoms. G. A. JEFFREY AND G. S. PARRY. Letter in *Nature* [*Lond.*] **169**, 1105–6 (*June* 28, 1952).

There are nine independent determinations in which the C(OH)COOH-group is planar. These can be explained by a significant electrostatic attraction between the hydroxyl and carbonyl oxygen atoms.

C. TURNER

539.13

7449. Inter- and intramolecular energy transfer processes. I. Nitro-compounds and hydrocarbons. C. REID. *J. Chem. Phys.*, **20**, 1212–13 (*Aug.*, 1952).

The addition compounds of aromatic nitro-compounds and hydrocarbons fluoresce appreciably only if the hydrocarbon component itself has a possible transition lying in the region where the nitro-complex might be expected from its absorption to emit. The resulting emission spectrum is very similar to that of the hydrocarbon component but much more strongly allowed. This is attributed to the breaking down of the $S \leftarrow T$ selection rule as the complex dissociates. A.

539.132

7450. Force constants in polyatomic molecules. W. J. O. THOMAS. *J. Chem. Soc.* (1952) 2383–9 (*June*).

General solutions have been obtained for the force constants occurring in the potential functions governing the stretching vibrations of the linear triatomic grouping in the molecules HNCO, HNCS, HN_3 and $CH_3 . CN$. Reasonable sets of force constants are chosen for these molecules, reference molecules whose force constants are known explicitly being used in conjunction with Gordy's relationships. A.

539.132

7451. Heat of formation of phenyl radical and the related bond dissociation energies. M. SZWARC AND D. WILLIAMS. Letter in *J. Chem. Phys.*, **20**, 1171–2 (*July*, 1952).

The Ph–Br bond dissociation energy, assumed to be identical with the activation energy of the reaction of dissociation, has been found to be 70·9 kcal/mole; the value of 69·6 kcal/mole has been calculated for the heat of formation of the phenyl radical. The values are subjected to an error of ±1·5 to 2 kcal/mole. Dissociation energies of other bonds have also been calculated. F. LACHMAN

539.132

7452. The relationship between dissociation energies and interaction constants in the potential function, for polyatomic molecules. P. TORKINGTON. Letter in *J. Chem. Phys.*, **20**, 1174–5 (*July*, 1952).

A generalized molecular potential function is derived in terms of the components of the dissociation energy, from the Morse function for diatomic molecules. Comparison with the usual valence-force potential, involving the interaction constants, establishes the relationship. H. H. GREENWOOD

539.132 : 532.133

Viscosity and molecular structure. *See Abstr.* 7065

539.132

7453. The abnormal rotation in the collision of H_2O molecule with electron. H. HORIE, T. NAGURA AND Y. HONDA. *Sci. Pap. Osaka Univ.*, *No.* 21, 7 *pp.* (*Feb.*, 1951).

The diatomic fragment OH dissociated from the water molecule by electron impact is in an excited electronic state and possesses an abnormal rotational energy. From the view-point of exchange collision, the two different kinds of dissociation processes may be considered as follows: (*a*) $H_2O\left(\begin{matrix}singlet,\\ \text{ground state}\end{matrix}\right) + e \rightarrow H_2O\left(\begin{matrix}singlet,\\ \text{excited state}\end{matrix}\right) \rightarrow H(^2S) + OH\left(\begin{matrix}^2\Sigma^+,\\ \text{excited state}\end{matrix}\right)$ or (*b*) $H_2O\left(\begin{matrix}singlet,\\ \text{ground state}\end{matrix}\right) + e \rightarrow H_2O\left(\begin{matrix}triplet,\\ \text{excited state}\end{matrix}\right) \rightarrow H(^2S) + OH\left(\begin{matrix}^2\Sigma^+,\\ \text{excited state}\end{matrix}\right) + \begin{matrix}abnormal.\\ rotation.\end{matrix}$ A.

539.132

7454. On the abnormal rotation of OH radicals. K. NIIRA. *J. Phys. Soc. Japan*, **7**, 193–9 (*March–April*, 1952).

The abnormal rotational intensity distribution of the OH band spectrum $^2\Sigma^+ - {}^2\Pi$ emitted through discharge in water vapour has been interpreted to be due to simultaneous dissociation of H_2O and excitation of OH. A quantum-mechanical calculation of electronic energies of H_2O molecules by semi-empirical AO approximation shows that in two electronically excited states of H_2O, both of them being characterized by symmetry type of $^1A_1$ and $^3B_2$, respectively, a H atom of H_2O takes a path of particular direction in the dissociation process to excite OH* radical ($^2\Sigma^+$) into a rotational state. Such an elementary process for dissociation can be understood by an interaction between different symmetry types resulting from deformation of the configuration of H_2O molecule from an isosceles into a scalene triangle at the decomposition. Greater energy released in the $^3B_2$ than in the $^1A_1$ is responsible for the abnormal rotation ($J \sim 20$) of OH* from the $^3B_2$, and the $^1A_1$ gives OH* of $J \sim 5$. Another treatment by MO method is reviewed. A.

539.132

7455. Statistical theory of hindered rotation in molecular crystals. T. NAKAMURA. *J. Phys. Soc. Japan*, **7**, 264–9 (*May–June*, 1952).

The basis of the theory is the Kirkwood model. Some values characteristic of the phase transition due to molecular hindering are calculated. For the Curie

point, H_c', 1·075, 0·615 and 0·434 for the square, simple cubic and body-centred lattices respectively were obtained, assuming $J/2 \cos \gamma$, for the interaction between two neighbouring molecules, whose relative orientation is specified by γ, and putting $H = J/2kT$. The leap values of the specific heat, $\Delta C_v/R$, are obtained as 2·280, 2·466 and 2·514 for the square lattice, etc. In contrast with the theory of binary alloys, $\Delta C_v/R$ is not improved over the Bragg–Williams' value 2500. It is different from Chang's result, according to which $\Delta C_v/R$ is larger than the Bragg–Williams value, considerably. However, Chang's point of view is criticized. A.

539.132

7456. Classification of the framework vibrations of 1 : 3-dioxan and molecular structure of acetaldoxan. H. VOETTER AND F. WOLLRAB. *Acta Phys. Austriaca*, **5**, 529–35 (*No.* 4, 1952) *In German.*

The normal vibrations of the 1 : 3-dioxan molecule have been calculated on the basis of a simple valency force field. The results agree with the work of Ramsay and Sutherland on the Raman spectra of cyclohexane and with that of Ramsay on 1 : 4-dioxan. The values of the valency force constants k_{C-C} and k_{C-O} and the deformation force constants c_{C-C-C} and c_{C-O-C} used in the calculation were the same as those used in work on the above compounds. Assuming that the deformation force constants increase somewhat in the order C–C–C, C–C–O, O–C–O, the experimental vibrations are classified. Since the ring frequency for 1 : 3-dioxan also occurs in the spectrum of acetaldoxan the structure ascribed to this compound by Späth is confirmed. A. J. MEE

539.132 : 535.343

7457. Application of action-coefficients to the study of vibration spectra of polyatomic molecules. I. Formulae for determining the strength distribution in molecular bonds, the form of vibrations and of frequency interaction under vibrations of molecules. P. G. MASLOV AND S. A. ANTIPINA. *Zh. Eksper. Teor. Fiz.*, **22**, 164–71 (*No.* 2, 1952) *In Russian.*

If the potential function is expressed in terms of generalized forces the action coefficients are invariant under co-ordinate transformations. These coeffs. and the corresponding solutions of equations of motion have been determined theoretically. J. JACOBS

539.132 : 535.343

7458. Application of action-coefficients to the study of vibration spectra of polyatomic molecules. II. Action coefficients, frequencies, form of vibrations, distribution of forces and analysis of the character of frequency interactions for acetylene and deutero-acetylenes. P. G. MASLOV AND S. A. ANTIPINA. *Zh. Eksper. Teor. Fiz.*, **22**, 172–83 (*No.* 2, 1952) *In Russian.*

The system of action-coeffs. for C_2H_2 is calculated. With it are determined: spectrum of fundamental frequencies, distribution of forces in bonds, and shape of vibrations. The numerical values for frequencies lie within a few cm^{-1} of observed ones. An approximate frequency interaction is determined for C_2H_2, C_2HD, C_2D_2. J. JACOBS

539.132 : 535.343–15

Rotation vibration spectra and structure of simple polyatomic molecules. *See Abstr.* 7166

539.132 : 541.6

Rotational isomerism and the vibrational spectrum of *sym*-dideuterodibromoethane. *See Abstr.* 7650

539.132

7459. The electronic energies of the CH_2 radical. K. NIIRA AND K. OOHATA. *J. Phys. Soc. Japan*, **7**, 61–5 (*Jan.–Feb.*, 1952).

The CH_2 radical is considered to have the bond angle of 140 degrees and the dissociation energy of 205 kcal. It may be possible to explain these values of the CH_2 radical by the calculation of its electronic energies, assuming both the s^2p^2 and sp^3 electronic configurations of the C atom, and using the atomic orbital approximation. The result of our calculation shows that the ground state of CH_2 has the dissociation energy 9·25 eV (204 kcal) and the equilibrium bond angle 140 degrees, the symmetry state of which being $^3B_1$ having its nodal plane in the molecular plane. If the result of the calculation is compared with the estimation given by Mulliken using the method of molecular orbital, it may be observed that there is a good correspondence between the two methods of approximation except for a few numbers of term reversal. A.

539.132

7460. π-electrons and σ-electrons. C. A. COULSON, N. H. MARCH AND S. ALTMANN. *Proc. Nat. Acad. Sci.* [*Wash.*] **38**, 372–8 (*April*, 1952).

Charge density diagrams for benzene calculated according to both the molecular orbital and Thomas–Fermi statistical methods are presented. Inability to distinguish clearly π-from σ-electron distributions places some doubt on the validity of methods which treat π-electrons as a separate system. Furthermore, a theoretical treatment of the ground and excited states of ethylene using the full 12-electron Hamiltonian illustrates the importance of π–σ resonance. H. H. GREENWOOD

539.132

7461. On the distribution of charge in the CO bond of CO_2. H. SHULL. *Proc. Nat. Acad. Sci.* [*Wash.*] **38**, 400–8 (*May*, 1952).

Self-consistent field MO calculations were used and compared with an equivalent charge distribution, leading to the same net moment—2·312 atomic units. Most of the charge asymmetry arises from hybridization of s and z orbitals on 0, and from overlap of C and O orbitals. If much inner-outer shell mixing occurs the results may need revision. J. JACOBS

539.132

7462. On the electronic states of the doubly-charged negative ions of oxygen in oxide crystals. J. YAMASHITA AND M. KOJIMA. *J. Phys. Soc. Japan*, **7**, 261–3 (*May–June*, 1952).

The O atoms are supposed to become the doubly-charged negative ions within oxide crystals. There is, however, no experimental evidence of the existence of such ions in gas phase, which fact suggests that they are probably very unstable in the free state. It may therefore reasonably be supposed that they are stable only within oxide crystals due to the effects of the surrounding ions. In order to elucidate the above situation quantitatively, an attempt has been made to work out the electronic states of the O ions within the oxide crystals by the variational method

adopted already for the calculation of the cohesive energy of LiF. It has thus been confirmed, for MgO, that the doubly-charged negative ion of O may be actually stable in such crystals. Furthermore, the electronic affinity of the ions and diamagnetic susceptibility of MgO crystals have also been calculated; the results seem to show quite good agreement with the experimental observations. A.

539.132

7463. On the electronic spectra of *o*-dichlorobenzene in the solid state. S. C. SIRKAR AND H. N. SWAMY. Letter in *J. Chem. Phys.*, **20**, 1177 (*July*, 1952).

539.132

7464. The lowest triplet levels of aromatic hydrocarbons. C. REID. *J. Chem. Phys.*, **20**, 1214–15 (*Aug.*, 1952).

New data for anthracene and naphthacene suggest that the lowest triplet levels of polyacenes are of species ${}^3L_b$. This makes the 39 000 cm^{-1} singlet band of benzene of symmetry B_{2u} as was originally proposed and not B_{1u} as was later suggested. A.

539.132

7465. *l*-Type doubling transitions in HCN and DCN. T. L. WEATHERLY AND D. WILLIAMS. *Phys. Rev.*, **87**, 517–21 (*Aug.* 1, 1952).

Direct transitions between levels split by *l*-type doubling have been observed for $J = 9$, 10 and 11 in HCN and for $J = 10$, 11 and 12 in DCN. The *l*-type doubling coefficient calculated from the observed line frequencies shows a slight decrease with increasing J for both molecules. While the observed values of the *l*-type doubling coefficient q are in good agreement with those calculated theoretically, the slight variation of q with J was not expected. This variation of q with increasing J involves a negative term in q proportional to $J(J+1)$ and may therefore be related to the effects involved in centrifugal stretching of the rotating molecule. A.

539.132

7466. On an analytical expression of the potential-barrier/free-valence relation. P. YVAN. *C.R. Acad. Sci.* [*Paris*] **234**, 2287–9 (*June* 4, 1952) *In French.*

The potential barrier is shown to be a function not only of bond number (and hence of free valence) but also of the charge at an atom. The results do not apply to non-alternant molecules, nor to ionic reactions with free radicals. J. JACOBS

539.133

7467. The bent excited state of acetylene. G. W. KING AND C. K. INGOLD. Letter in *Nature* [*Lond.*] **169**, 1101–2 (*June* 28, 1952).

Analysis of the absorption band systems of C_2H_2 and C_2D_2 at 2400–2100Å gives a plane centrosymmetric zig-zag structure for which the dimensions and frequencies are given. The oscillator strength for the transition from the normal to the excited state is 8×10^{-5}. The C–C bond is a three-electron bond, as indicated by molecular orbital theory. C. TURNER

539.133

7468. Size and shape of polyelectrolyte molecules in solution. T. L. HILL. Letter in *J. Chem. Phys.*, **20**, 1173–4 (*July*, 1952).

An outline is given of a theory where the equilibrium size and shape of polyelectrolyte molecules is determined as the geometry with lowest free energy.

G. I. W. LLEWELYN

ATOMIC STRUCTURE . NUCLEUS ISOTOPES 539.15

539.152.1

7469. On the binding energies of light nuclei. J. SANADA AND Y. YOSHIZAWA. *J. Phys. Soc. Japan*, **7**, 99–102 (*Jan.–Feb.*, 1952).

The binding energies of the last neutron and proton, and of the last neutron-proton pair in nuclei, whose mass number $A \leq 36$, are investigated by utilizing mass values. Those of the last neutron-proton pair in nuclei having $A \sim 61$ are also investigated. The curves of the binding energy *v.* nucleon number show large binding energies and breaks at 6 and 14 neutrons or protons and 28 protons like those occurring at the positions of shell closing in atoms. A.

539.152.1

7470. Energy levels in C^{12}, Al^{27}, and Na^{23} using a scintillation spectrometer for heavy particles. H. F. STODDART AND H. E. GOVE. *Phys. Rev.*, **87**, 262–6 (*July* 15, 1952).

Energy levels in C, Al and Na have been measured using a "proportional" NaI scintillation counter to determine energies of outgoing protons from inelastic proton scattering at 7·26 MeV with the following results: C^{12}: 4·45 MeV; Al^{27}: 0·84, 1·01, 2·23, 2·77, 3·03, 3·71, 4·00, 4·47, 4·60, 4·87, 5·43 MeV; Na^{23}: 2·10, 2·37, 2·69, 3·01, 3·70, 3·92, 4·45 MeV. Factors limiting the resolution are presented, and it is found that the standard deviations of the distributions are consistent with 2·4 photoelectrons produced at the photocathode of the RCA 5819 per keV of particle energy lost. A.

539.152.1

7471. Nucleon momentum distributions in deuterium and carbon inferred from proton scattering. I. J. B. CLADIS, W. N. HESS AND B. J. MOYER. *Phys. Rev.*, **87**, 425–33 (*Aug.* 1, 1952).

Nuclear internal momentum distributions of D, C and O are inferred from the energy distributions of the protons obtained at various scattering angles when 340-MeV protons are incident on these nuclei. The energy spectra of the protons from D agree with the spectra obtained theoretically by using the deuteron nucleon momentum distribution given by the Fourier transform of the Hulthén wave function. Unfortunately, the experimental method is not so good as to distinguish differences in the portion of the deuteron wave function within the potential interaction. Protons obtained from C and O have energy spectra that are consistent with the use of a Gaussian nucleon momentum density distribution having a $1/e$ value corresponding to a nucleon energy of 16 ± 3 MeV. Proton yields from D nearly equal those expected from free proton-nucleon collisions. O gives proton yields in the spectral regions investigated that are 16/12 times the corresponding yields from C. A.

539.152.1

7472. The di-neutron periods of pure elements. II. H. WATZLAWEK. *Öst. Ingen. Arch.*, **6**, 126–31 (*No.* 2, 1952) *In German.*

For Pt I, see Abstr. 5971 (1952). Further elaborations on the subject of magic numbers and the supposed significance of the di-neutron n_0^2 in nuclear structure. W. J. SWIATECKI

539.152.2

7473. Precise measurement of the F^{19} magnetic moment. T. KANDA. *J. Phys. Soc. Japan*, **7**, 296–8 (*May–June*, 1952).

Using a new circuit, a precise measurement of the frequency ratio of nuclear magnetic resonance of F nucleus to that of proton in HF aq. was performed at magnetic field of about 1800 gauss. The value $\nu_F/\nu_H = 0{\cdot}940816$ was obtained with the smallest error $\pm 0{\cdot}000009$ compared with the values by other research workers. A.

539.152.2

7474. Modulation effects in nuclear magnetic resonance. J. H. BURGESS AND R. M. BROWN. *Rev. Sci. Instrum.*, **23**, 334–6 (*July*, 1952).

The perturbing effect of magnetic field modulation in nuclear magnetic resonance under conditions of high resolution is discussed. When the modulation frequency is greater than the resonance line width, sideband resonances separated in frequency by the modulation frequency are observed, having line shapes of either absorptive or dispersive form or a mixture of the two depending on the phasing of the lock-in detector. The form and distribution of these sidebands is satisfactorily accounted for using Bloch's equations. A.

539.152.2

7475. Nuclear radiofrequency spectra of H_2 and D_2 in high and low magnetic fields. H. G. KOLSKY, T. E. PHIPPS, JR, N. F. RAMSEY AND H. B. SILSBEE. *Phys. Rev.*, **87**, 395–403 (*Aug.* 1, 1952).

A new molecular beam apparatus of improved design is described which utilizes, among other improvements, a long homogeneous magnetic field with two separated oscillatory fields for high resolution and a method of phase shifting of the two fields which permits more accurate data-taking. The apparatus has been used to study the nuclear radiofrequency spectrum of H_2 and D_2 in magnetic fields of 1600 gauss and 6 gauss. The results are found to be consistent with Ramsey's theoretical expressions, provided the adjustable parameters are suitably selected. For H_2 the values for these parameters are that c equals $113\,800 \pm 210$ c/s and d equals $57\,680 \pm 40$ c/s, while for D_2 c equals 8790 ± 60 c/s and d equals $25\,240 \pm 20$ c/s. These values for the parameters imply that the rotational magnetic field H' at the nucleus in H_2 is $26{\cdot}73 \pm 0{\cdot}05$ gauss while in D_2 it is $13{\cdot}44 \pm 0{\cdot}09$ gauss, that the internuclear spacing r in H_2 is such that when averaged over the zeroth vibrational state and the first rotational state $(1/r^3)^{-\frac{1}{3}}$ equals $(0{\cdot}74673 \pm 0{\cdot}00018) \times 10^{-8}$ cm, that the deuteron quadrupole interaction $eQ(\partial^2 V_e/\partial z_0^2)$ equals $(1{\cdot}4907 \pm 0{\cdot}0015) \times 10^{-21}$ ergs, that the quadrupole moment Q of the deuteron equals $(2{\cdot}738 \pm 0{\cdot}014) \times 10^{-27}$ cm^2, and that the nuclear magnetic shielding constant σ for H_2 is $(2{\cdot}65 \pm 0{\cdot}03) \times 10^{-5}$. A

539.152.

7476. Nuclear quadrupole resonance frequencies o the Cu isotopes in polycrystalline (covalent) compounds H. KRÜGER AND U. MEYER-BERKHOUT. *Z. Phys.*, **132** 171–8 (*No.* 2, 1952) *In German.*

These frequencies were found in the metre wav region. $Q(Cu^{63})/Q(Cu^{65}) = 1{\cdot}0806 \pm 0{\cdot}0003$. Struc tures of Cu_2O and $KCu(CN)_2$ are discussed which lead to the observed values of the resonance frequencies. L. PINCHERL

539.152.

7477. Determination of the nuclear magnetic momen of As^{75} from the Zeeman effect of a nuclear quadrupol resonance transition. H. KRÜGER AND U. MEYER BERKHOUT. *Z. Phys.*, **132**, 221–30 (*No.* 2, 1952) *I German.*

An absorption line of frequency $116{\cdot}26 \pm 0{\cdot}0$ Mc/s was observed at room temperature in arseni trioxide. This line is due to a transition of the As^7 nucleus between two terms whose energy differenc is due to the interaction of the nuclear quadrupol moment with the inhomogeneous magnetic field o the molecule. The Zeeman effect of the line wa observed in a single crystal with a field of abou 100 oersted, and the value $1{\cdot}44 \pm 0{\cdot}03$ n.m. wa deduced for the nuclear magnetic moment.

L. PINCHERL

539.152.

7478. Nuclear magnetic moments. C.-R. EXTER MANN, G.-J. BÉNÉ AND P.-M. DENIS. *Arch. Sci.*, 5 65–83 (*No.* 2, 1952) *In French.*

A review of methods of measurement, results an deductions concerning the structure of nuclei.

L. PINCHERL

539.15

7479. Binding energies for electrons of differen types. C. E. MOORE AND H. N. RUSSELL. *J. Re Nat. Bur. Stand* [*Wash.*] **48**, 61–7 (*Jan.*, 1952).

The binding energy of an electron of given type i any state of a neutral or ionized atom may be define as that required to remove it along successive term of a spectral series to its limit. The data regardin electron configurations and limits collected in Atom Energy Levels [Abstr. 665, 7202 (1949)], permit th calculation of these in a great number of case The present tables give the maximum energy resultin from the addition of an electron of given type (suc as 4*p*) to the ground states of singly or doubly ionize atoms of the elements H through Nb; and, whe desirable, to one other low state (two in the cases Sc and Y). These increase smoothly with atom number except for a remarkable break after a shell ten *d*-electrons has been half filled.

539.1

7480. Intensities of forbidden lines of atoms p^n-configuration. T. YAMANOUCHI AND H. HOR *J. Phys. Soc. Japan*, **7**, 52–7 (*Jan.–Feb.*, 1952).

The intensities of the electric quadrupole and t magnetic dipole radiations of atoms and ions corr sponding to the transitions between the states arisi from the same electron configuration p^n are calculate

In constructing the eigenfunctions for each J-state, spin-orbit and spin-spin interactions between different electrons as well as the usual spin-orbit interactions of individual electrons are taken into account to make fit with the observed multiplet intervals. The results are expected to be improved by the inclusion of these previously neglected interactions. A.

539.153

7481. Line strengths for transitions $d^n \rightarrow d^{n-1}p$ and $d^n \rightarrow d^{n-1}f$, and probabilities of photo-ionization and recombination $d^n \rightleftarrows d^{n-1}$. H. HORIE. *J. Phys. Soc. Japan*, **7**, 58–61 (*Jan.–Feb.*, 1952).

General formulae for the line strengths of transition as well as the probabilities of photo-ionization and recombination are obtained. They are expressed in simple forms by Racah's coefficients of fractional parentages. Auxiliary tables useful for their computation for the case $l = 2$ are given. A.

539.153

7482. Mass corrections to hyperfine structure. E. E. SALPETER AND W. A. NEWCOMB. Letter in *Phys. Rev.*, **87**, 150 (*July* 1, 1952).

Two types of correction terms are treated, one involving the exchange of one, and the other the exchange of two transverse photons between the proton and the electron. With these corrections $1/\alpha = (137{\cdot}0355 \pm 0{\cdot}0010)(1 + \frac{1}{2}\delta)$; δ, whose absolute value may exceed 2×10^{-5}, arises from structure effects of the proton magnetic moment. L. PINCHERLE

539.153

7483. Mass corrections to the fine structure of hydrogen-like atoms. E. E. SALPETER. *Phys. Rev.*, **87**, 328–43 (*July* 15, 1952).

A relativistic 4-dimensional wave equation, derived previously, for bound states of a 2-body system is discussed further. For any "instantaneous" interaction function an exact 3-dimensional equation is derived from it, similar to, but not identical with, the Breit equation. A perturbation theory is developed for a small additional noninstantaneous interaction. Using this covariant method, corrections of relative order $\alpha(m/M)$ to the fine structure of H, due to the finite mass of the nucleus, are calculated. No terms of this order were obtained in previous approximate treatments using the Breit equation. Some of the terms obtained contain $\log\alpha$ as a factor. It is shown that these special terms can also be derived simply by means of orthodox quantum electrodynamics and perturbation theory. These corrections to the fine structure are $+0{\cdot}379$ Mc/s for the $2s$ state of H and $-0{\cdot}017$ Mc/s for the $2p$ state. For H-like atoms with heavier nuclei the corrections are roughly (Z^5/A) times those for H. A.

539.153

7484. Transition probabilities in sharp and diffuse series of potassium. D. S. VILLARS. *J. Opt. Soc. Amer.*, **42**, 552–8 (*Aug.*, 1952).

The International Business Machines Card Programmed Calculator has been wired to compute wave functions of several terms of the sharp and diffuse series of potassium (up to $11s$ and $9d$). Transition probabilities and "oscillator" and "line strengths" estimated from these are reported. The computational procedure employed was that developed by Biermann and Lübeck. Perfect agreement with Biermann and Lübeck was obtained for a check calculation of the $4p$ wave function. The reliability of the results is discussed. A.

539.153

7485. Wave functions for excited states of mercury and potassium. B. MISHRA. *Proc. Camb. Phil. Soc.*, **48**, 511–15 (*Pt* 3, 1952).

These are based on the self-consistent wave functions calculated by Hartree. In the case of Hg the field used in calculating the (nl) orbital was taken to be the same as that for the $6s$ orbital of the normal state, exchange was neglected. Similar methods were used for K, but a term was added to the potential to allow for polarization. Tables of normalized wave functions are given for the $6p$, $6d$, $7s$, $7p$ and $7d$ states of Hg and for the $4p$ state of K. L. PINCHERLE

539.153 : 530.145

7486. Effect of electromagnetic radiation on the Lamb shift. F. C. AULUCK AND D. S. KOTHARI. *Proc. Roy. Soc. A*, **214**, 137–42 (*Aug.* 7, 1952).

If there is an external radiation field surrounding the atom, it influences the value of the Lamb shift. It is shown that for black-body radiation at temperature comparable to 10^5 degrees, the change in the Lamb shift due to the influence of radiation is of the same order as the Lamb shift itself. Whereas the transitions to the continuum largely contribute to the Lamb shift (in the absence of radiation), the change in the Lamb shift is largely due to transitions to discrete states. A.

539.153.4

7487. Electronic wave functions. VI. Some theorems facilitating the evaluation of Schrödinger integrals of vector-coupled functions. S. F. BOYS. *Philos. Trans A*, **245**, 95–115 (*No.* 893, 1952).

For Pt V, see Abstr. 7197 (1951). The theorems reported here provide some powerful additional relations to the general theory of the reduction of Schrödinger integrals completed in part V. One result of these is to establish a number of relations between the various vector-coupling coefficients and thus to reduce considerably the labour of calculation of these. A second result is to provide a method of evaluating the two-electron electrostatic integrals which is a complete alternative to the c^k method which has generally been used previously. This appears to be simpler and more powerful. A third result is only applicable to a restricted class of integrals and only to particular terms in the formulas for these, but where applicable it makes trivial the evaluation of the terms concerned and actually simplifies about three-quarters of the integrals normally occurring. These methods have been found to be extremely useful in the convergent variational calculations of atomic wave functions, and will also be applicable to all problems which require the evaluation of Schrödinger integrals between vector-coupled functions. A.

539.153.4

7488. Electronic wave functions. VII. Methods of evaluating the fundamental coefficients for the expansion of vector-coupled Schrödinger integrals and some values of these. M. J. M. BERNAL AND S. F. BOYS. *Philos. Trans A*, **245**, 116–38 (*No.* 893, 1952).

The evaluation of all types of numerical data required for the expansion of Schrödinger matrix

elements between antisymmetric vector-coupled functions in terms of one- and two-electron integrals is described. Some coefficients are effectively evaluated by the defining relations, but others can be most briefly evaluated by derived procedures. The values of ranges of all the necessary coefficients are given. The expansions of a set of integrals between functions derived from p^6S^1 by single and double replacements are also given. These constitute a set which is used repeatedly in the variational treatment of all atoms more complicated than fluorine. A.

539.153.4

7489. Electronic wave functions. VIII. A calculation of the ground states Na^+, Ne and F^-. M. J. M. Bernal and S. F. Boys. *Philos. Trans A*, **245**, 139–54 (*No.* 893, 1952).

The variational method was applied to a linear combination of Slater determinants. The wave functions are probably more accurate than any others previously reported for these ions. Some innovations in the method of calculation have been examined and have provided interesting empirical experience. The expansions of the relevant Schrödinger matrix elements are derived. This is the first time that a convergent method of calculation has been applied to systems of such complexity. A.

539.155.4

7490. Mass of V^{50}. W. H. Johnson, Jr. Letter in *Phys. Rev.*, **87**, 166–7 (*July* 1, 1952).

The mass spectrography of doublets consisting of V^{50}, Ti^{50} or Cr^{50} with C_4H_2 gave $M(V^{50}) - M(Ti^{50}) = 2{\cdot}39 \pm 0{\cdot}12$ MeV and $M(V^{50}) - M(Cr^{50}) = 1{\cdot}18 \pm 0{\cdot}12$ MeV, showing that failure to detect decay of V^{50} must be due to long life and not low decay energy. W. J. Swiatecki

RADIOACTIVITY α, β-, AND γ-RAYS 539.16

539.16 : 539.172.4

7491. Radioactive deposits found at Ottawa after the atomic explosions of January and February 1951. D. C. Rose and J. Katzman. *Canad. J. Phys.*, **30**, 111–16 (*March*, 1952).

γ-Ray counter equipment, in continuous operation at Ottawa, Canada, indicated that considerable radioactive matter fell on Jan. 29 and again on Feb. 7. The decay period of this material was measured and is consistent with the assumption that the material consisted mainly of products of fission. The fall on Jan. 29 came from an explosion on Jan. 27 and the Feb. 7 material appeared to be 3 to 5 days old. The quantity can be estimated only very roughly and is thought to be of the order of one microgram radium equivalent per m^2. A.

539.16.08

7492. Deduction of the concentrations of uranium and thorium in radioactive substances using the photographic method. G. Imbo and L. Casertano. *Ann. Geofis.*, **5**, 1–12 (*Jan.*, 1952) *In Italian.*

Continuing work reported in Abstr. 3716 (1951) formulae are here given to obtain the statistical distribution of α-particles as gathered on photograph plates, in function of the projection on the plate the particle trajectory inside of the emulsion, f thickness values varying from zero to the limit thic ness represented by the particle range in the substan under examination. Starting from these formula distributions are indicated both for the whole grou of U and A, and for the Th group. Distributio are also indicated for fixed ratio values of U weig concentrations (C_U) in respect of Th weight concentr tions (C_{Th}), and a description given of the meth used for the calculation not only of ratios C_U/C_T but also of the single concentrations C_U and C_T as experimentally deduced from the projections the plate of the trajectories in the emulsion of t α-particles which are emitted by the substance und examination.

539.16.

7493. Locating buried radioactive sources. R. Condit and J. D. Graves. *Nucleonics*, **10**, 18– (*June*, 1952).

The optimum procedure in searching for buri radioactive sources is investigated with particul reference to Co^{60} point sources. Radiation intensi is determined as a function of depth of the sour below the surface, height of the detector above t surface and the radial distance along the surface fro the source. It is concluded that in general the sear should be made with the detector at a high le above the surface. An optimum angle is fou between the line of source and detector and t assumed plane surface, as a function of burial dep L. R. Shephe

539.16.

7494. A method for estimating low levels of radi active contaminants in water. A. H. Emmons a R. A. Lauderdale. *Nucleonics*, **10**, 22–3 (*June*, 195

A water monitor, designed for continuous operati and capable of measuring very low concentrations active contaminants, is described. The water circulated through an ion exchange resin bed 200 ml volume which surrounds a glass-w (30 mgm/cm²) G.M. counter. The resin bed co centrates the activity and a recorder plots the build of counting rate as a function of the volume of wa which has passed through the bed. The resin bed regenerated by means of HCl which replaces act contaminant cations by hydrogen ions. The to capacity of the bed is 80 gallons of water contain 120 p.p.m. of dissolved solids. L. R. Shephe

539.16

7495. Radiosensitivity of alkali–halide cryst H. Friedman and C. P. Glover. *Nucleonics*, 24–9 (*June*, 1952).

The use of alkali halide crystals for colorime dosimeters is reviewed. The action of ionizing ra tion is to form *F*-centres (electrons trapped at lat anion vacancies) in number related to the radiat dosage received. The density of *F*-centres can observed from the absorption of transmitted light the colour of the crystal. Dosages of 10–100 r r be detected in this manner. Sensitization of crys by introduction of alkali hydride in solid solut

results in a slight increase in sensitivity and a considerable reduction in rate of decay of the *F*-centres due to thermal bleaching. More sensitive methods of detecting *F*-centres involving the measurement of photoconductivity or luminescence during the bleaching process permit measurements of dosages of the order of mr. L. R. SHEPHERD

539.16.08 : 551.594.14

7496. A monitor for natural atmospheric radioactivity. M. H. WILKENING. *Nucleonics*, **10**, 36–9 (*June*, 1952).

The apparatus described measures the activity of particulate matter collected from the atmosphere on a moving metal tape. The airborne particles are deposited on the tape, in an electrostatic precipitator (through which the air is drawn at a rate of 0·03 m³/min) by means of corona points kept at −10 kV with respect to the tape. The tape is fed continuously through the precipitator and thence under a scintillation-type α-counter or an end-window β-counter. A point on the tape spends 30 min in the precipitator and takes a further 22 min to reach the detector. The activities measured are mainly radon decay products (effective $t_{\frac{1}{2}} = 40$ min), but by slowing down the tape considerably and moving the detector further from the precipitator, it is possible to concentrate on thoron decay products. Results showing diurnal variation of airborne activities are given.

L. R. SHEPHERD

539.163

7497. Neutron-deficient mercury isotopes. R. W. FINK AND E. O. WIIG. *J. Amer. Chem. Soc.*, **74**, 2457–60 (*May* 20, 1952).

High energy bombardments with protons on Au and α-particles on Pt were performed to study neutron-deficient Hg isotopes. Two new Hg isotopes have been definitely identified: Hg^{192}, $T_{\frac{1}{2}} = 5·7 \pm 0·5$ hr, 1·18 MeV. β^+, 0·18 MeV conversion electrons, *K*, *L* *X*-rays and 1·39 MeV γ-ray; parent of 4·0 hr Au^{192}. Hg^{193}, $T_{\frac{1}{2}} = 10·0 \pm 0·5$ hr, no β^+, *K*, *L* *X*-rays, 0·18 MeV conversion electrons; parent of 15·3 hr Au^{193}. Tentatively identified was Hg^{195} of 31 hr half-life, although this value may be in error owing to masking by the isomeric pair at Hg^{197}. Decay of Hg^{195} leaves Au daughter of 180-day half-life; although this genetic relation has not been established quantitatively, long-lived Au daughter has been observed. No positrons are emitted by Hg^{195} but *K* and *L* X-rays are detected. No activity was found which can be allocated to Hg^{194}. Positron-emitting 39·5-hr Au^{194} was not present among the Au daughters. An unidentified 2·0-hour Hg activity, present in increasing yield with increasing proton bombardment energy, must have mass number 191 or lower. The genetic relationships between Hg^{192}–Au^{192} and between Hg^{193}–Au^{193} have been established quantitatively. A.

539.163

7498. Half-life and radiations of Tc^{100}. G. E. BOYD, Q. V. LARSON AND G. W. PARKER. Letter in *Phys. Rev.*, **86**, 1051 (*June* 15, 1952).

A positron activity (70 sec, 2·1 MeV) previously [Abstr. 3915 (1948)] assigned to Tc^{100} was shown to be due to F^{17} from impurities. Milligram amounts of separated Tc^{99} were irradiated with thermal neutrons and the radiations examined: a β-activity of $E_{max} = 2·8 \pm 0·2$ MeV with a $\frac{1}{2}$-life of $15·8 \pm 0·2$ sec was obtained, accompanied by γ-radiation, and assigned to Tc^{100}. No evidence was found of a possible long-lived isomer of Tc^{100}. A. O. STANESBY

539.163

7499. The 7 MeV level of ^{12}C. G. HARRIES AND W. T. DAVIES. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 564–5 (*July*, 1952).

Cloud-chamber experiments on the irradiation of Be by Po–Be α-particles indicated that the 7-MeV level of C^{12} emits electron-positron pairs; a γ-ray of ~2·5 MeV would also be expected by de-excitation to the 4·45-MeV level, but the intensity (about $\frac{1}{8}$th that of the 4·45-MeV γ-ray) is probably below the threshold of previous measurements. A. O. STANESBY

539.163

7500. Nickel 56. W. J. WORTHINGTON, JR. Letter in *Phys. Rev.*, **87**, 158 (*July* 1, 1952).

The Ni fraction from the spallation of Zn by 340-MeV protons, separated by ion exchange techniques, showed a $\frac{1}{2}$-life of $6·0 \pm 0·5$ days, attributed to Ni^{56} decaying to Co^{56}, mainly by *K*-capture; there are at least 4 γ-rays. A. O. STANESBY

539.163 : 539.166

7501. Isomers in tellurium 133. A. C. PAPPAS. Letter in *Phys. Rev.*, **87**, 162–3 (*July* 1, 1952).

Te^{133} ($\frac{1}{2}$-life 63 min) was isolated from the decay of fission-product Sb^{133}. A fast chemical separation showed a daughter activity of $\frac{1}{2}$-life 2 min. It is suggested that the 2-min activity is the ground state of Te^{133} and the 63-min activity an isomeric state; a tentative decay scheme is presented.

539.163 : 539.172.4

7502. Radioactivity produced in platinum by slow neutron capture. B. C. HALDAR. Letter in *Phys. Rev.*, **87**, 158–9 (*July* 1, 1952).

Radiations from neutron-irradiated Pt, separated from Au products, were investigated. The 3·4-day activity of Cork, *et al.* [Abstr. 6072 (1950)] was not found, confirming its assignment to Au^{199}.

A. O. STANESBY

539.163.2

7503. Germanium 75, a new nuclear isomer of $T = 42$ sec half-life. A. FLAMMERSFELD. Note in *Z. Naturforsch.*, **7a**, 295 (*March–April*, 1952) *In German.*

This was deduced from an analysis of the 42-sec activity consisting of γ-rays and 0·14-MeV conversion electrons resulting from neutron bombardment of Ge and As. W. J. SWIATECKI

539.163.2

7504. Two cases of isomerism in palladium. A. FLAMMERSFELD. Note in *Z. Naturforsch.*, **7a**, 296–7 (*March–April*, 1952) *In German.*

1. Pd^{107*} or ^{109*}: half-life, $T = 4·8 \pm 0·1$ min; radiations, 0·160-MeV conversion electrons and γ's; internal conversion coefficient, $\alpha = N_e/N_\gamma \sim 0·6$; reactions, Ag($n$, p), Pd(n, $2n$), Pd(n, γ), ($\sigma = 0·018 \times 10^{-24}$ cm²). 2. $Pd^{(105)*}$: $T = 23 \pm 2$ sec, 0·200 MeV conversion electrons and γ's, $\alpha \sim 0·4$; reactions, Pd(n, $2n$) and Pd(n, n). W. J. SWIATECKI

539.163.2

7505. Ruthenium 94. A. VAN DER WIEL AND A. H. W. ATEN, JR. Letter in *Physica*, **18**, 356 (*May*, 1952).

Examination of Ru and Tc fractions from the irradiation of Mo with 52-MeV He ions indicated the presence of Ru^{94}, probably formed from $Mo^{92}(\alpha, 2n)Ru^{94}$ and decaying by emission of positrons with $E_{max} \sim 2{\cdot}7$ MeV to Tc^{94}, with a $\frac{1}{2}$-life of ~57 min. A. O. STANESBY

539.163.2

7506. Determination of the transition probabilities for *K*-capture and positron emission of ^{65}Zn, using Geiger–Müller counters. J. K. MAJOR. *C.R. Acad. Sci.* [*Paris*] **234**, 2276–7 (*June* 4, 1952) *In French.*

The β-, γ- and X-ray spectra of Zn^{65} were investigated separately and in coincidence, using calibrated G.M. counters and selective absorbers. $44{\cdot}8 \pm 2{\cdot}1\%$ of the *K*-captures lead to the 1·1-MeV excited state of Cu^{65}; positrons are emitted in $2{\cdot}5 \pm 0{\cdot}1\%$ of the disintegrations and appear to go to the ground state. The branching ratio P_K/P_+ is $21{\cdot}3 \pm 1{\cdot}4$, agreeing approx. with the theoretical value for a second forbidden transition (30 for $\Delta J = 1$, $\Delta L = 2$).

A. O. STANESBY

539.163.2

7507. An investigation of the decay scheme of ^{153}Sm. R. C. BANNERMAN. Letter in *Proc. Phys. Soc.* [*Lond.*] *A*, **65**, 565–6 (*July*, 1952).

Scintillation counter measurements of the β-, γ- and $(\beta + \gamma)$-spectra, and of γ-γ and β-γ coincidences of 47-hr Sm^{153} indicate agreement with the measurements of Hill and Shepherd [Abstr. 3400 (1950)], with a total disintegration energy of 800 ± 20 keV; a decay scheme is suggested with levels of Eu^{153} at 101 and 170 keV. A. O. STANESBY

539.163.2

7508. The nuclide Ni^{56}. R. K. SHELINE AND R. W. STOUGHTON. *Phys. Rev.*, **87**, 1–4 (*July* 1, 1952).

Ni^{56} has been produced by the bombardment of the separated isotope Fe^{54} with 39-MeV α-particles. It is a $6{\cdot}4 \pm 0{\cdot}1$ day orbital electron capture activity with less than 1% positrons. Growth of its daughter Co^{56} makes the mass assignment certain and confirms the 6·4-day half-life. γ-rays of the following energies in MeV (and relative intensities) have been found: 0·17 (1·0), 0·28 (0·3), 0·48 (0·4), 0·81 (0·8), 0·96 (0·1), 1·33 (0·05), 1·58 (0·15) and 1·75 (0·02). The half-lives of most of these γ-rays have been followed individually and agree with the half-life quoted. The large number of γ's indicates that the decay scheme is complex. Coincidences have been found between the Co *K* X-rays and the γ's as well as between the γ-rays themselves. There is less than 10^{-4} α-branching. A.

539.163.2

7509. The decay scheme and angular correlation of Pr^{144}. D. E. ALBURGER AND J. J. KRAUSHAAR. *Phys. Rev.*, **87**, 448–52 (*Aug.* 1, 1952).

The decay scheme and angular correlation of Pr^{144} have been studied with lens spectrometer and scintillation counter techniques. The β-ray spectrum shows 3 groups with end points at $2{\cdot}965 \pm 0{\cdot}015$, $2{\cdot}3 \pm 0{\cdot}1$ and $0{\cdot}86 \pm 0{\cdot}1$ MeV, the first having a relative intensity of 90%, the others each about 5%. γ-ray were observed by photoelectric conversion and hav energies of $0{\cdot}695 \pm 0{\cdot}005$, $1{\cdot}48 \pm 0{\cdot}01$ and $2{\cdot}185 \pm$ 0·015 MeV and relative intensities of 1 : 0·4 : 1·1 respectively. The data indicate that β-emission take place to states in Nd^{144} at zero, 0·695 and 2·185 MeV The absorption of β-rays in coincidence with γ-ray shows 2 components with ranges of 0·34 an $1{\cdot}0$ g/cm^2 Al. The corresponding energies an intensities of these β-groups confirm the above deca scheme. γ-γ coincidences are also present and thei angular correlation has the form $1 - 0{\cdot}33 \cos^2$ characteristic of either a 1–2–0 or a 1–1–0 cascad It is suggested that the first excited state of Nd^{144} ha spin 2 and even parity and the second level spin Some of the features of Ce^{144} decay are described an the usefulness of this fission-product isotope as source of homogeneous photoneutrons is discussed.

539.163.

7510. The disintegration of Cs^{130}. A. B. SMITH A. C. G. MITCHELL AND R. S. CAIRD. *Phys. Rev.*, 8 454–6 (*Aug.* 1, 1952).

The disintegration of Cs^{130} (30 min) has bee studied with the help of a magnetic lens spectromet and a NaI(Tl) scintillation spectrometer. Cs^{130} decay to both Xe^{130} by positron emission and *K* electro capture and to Ba^{130} by negatron emission. Th end-point energy of the positrons is 1·97 MeV and the negatrons 0·442 MeV. Since no γ-rays othe than annihilation radiation were observed, it assumed that the disintegration leads to the groun state of both Xe^{130} and Ba^{130}.

539.163

7511. The disintegration of Ce^{144} and Pr^{144}. F. PORTER AND C. S. COOK. *Phys. Rev.*, **87**, 464–7 (*Aug.* 1952).

The radiations from the radioactive chain Ce^{144}–$Pr^{144} \rightarrow Nd^{144}$ have been investigated, using chemical purified sources. Ce^{144} (295-day half-life) decays the ground state of Pr^{144} through a 70% abunda β-group having a maximum energy of 304 ± 2 ke Conversion electrons have been observed whi indicate that within the Pr nucleus there are trans tions having energies 33·7, 53·5, 80·7, 100·3 a 134·2 keV. The predominant number of the Pr β-transitions go directly to the ground state of Nd through a $2{\cdot}97 \pm 0{\cdot}01$ MeV β-group. Conversio electrons from a weak 60·3-keV transition in N have been observed. Very weak γ-radiation havi energies 0·696, 1·5 and 2·185 MeV have be observed. The β-spectrum indicates that less th 2% of the β-transitions go to excited states of Nd 0·696 and 2·185 MeV. Using the evidence availab a disintegration scheme has been proposed.

539.1

7512. The complex alpha-spectra of Am^{241} and Cm F. ASARO, F. L. REYNOLDS AND I. PERLMAN. *Ph Rev.*, **87**, 277–85 (*July* 15, 1952).

The α-particle spectra of Am^{241} and Cm^{242} w studied in detail utilizing a 75-cm radius of curvatu 60° symmetrical electromagnetic analyser with pho graphic plate detection. The radioactive sources co taining up to 3 μg/cm^2 of active atoms in the case Am^{241} were prepared by vacuum sublimation. T

average geometry of the spectrograph is about 4 parts in 10^5. The energy dispersion on the photographic plate is about 3·4 keV/mm for 5-MeV α-particles, and the width at half maximum of these α-particle groups is about 7 keV. Six α-particle groups were found in Am^{241}, and their energies and abundances are 5·546 MeV, 0·23%; 5·535, 0·34%; 5·503, 0·21%; 5·476, 84·2%; 5·433, 13·6% 5·379, 1·42%. In Cm^{242} two α-particle groups were found whose energies and abundances are 6·110 MeV, 73% and 6·064, 27%. The α-decay scheme is correlated with γ-rays and conversion electrons observed for both Am^{241} and Cm^{242}. The various α-groups are evaluated with respect to the α-decay systematics, and the degrees of hindrance of the various α transitions are discussed with reference to normal trends in even-even nuclei. It is suggested that the totally different patterns of the spectra of the two nuclides are conditioned by the nuclear types. A.

539.164 : 778.3

7513. Investigations of complex structure in alpha-emission with nuclear emulsions. D. C. Dunlavey and G. T. Seaborg. Letter in *Phys. Rev.*, **87**, 165–6 (*July* 1, 1952).

Ilford G.5 emulsions have been used to measure the energy of conversion electrons coincident in origin with α-particles emitted by a number of nuclides. The nuclear energy level separation for each nuclide has been calculated from these electron energies by postulating the shell of conversion of the electrons. The percentage of α-particles having such conversion electrons is given in each case, and this represents a lower limit to the α-decay leading to the corresponding nuclear level. A. C. COATES

539.164.2

7514. On the calculation of alpha-decay energies. S. Jha and G. P. Dube. *Indian J. Phys.*, **26**, 15–27 (*Jan.*, 1952).

The α-disintegration energy has been calculated for some isotopes near $N = 82$ and $N = 126$, by using the Fermi–Weizsäcker formula; and its inadequacies have been discussed. As an alternative, the neutron and the proton binding energies have been used for this calculation, and this approach has been shown to be more satisfactory; B_N and B_P values in some isotopes from $Z = 59$ to $Z = 62$ have been estimated. A.

539.165

7515. On double β-decay. D. Ivanenko and N. Kolesnikov. *Dokl. Akad. Nauk SSSR*, **81**, 771–3 (*No.* 5, 1951) *In Russian.*

A theory without neutrinos is suggested in which there is direct coupling between a pair of nucleons and the electron-positron field. The new coupling constant is deduced from recent data on double β-decay ($g \sim 5 \cdot 5 \times 10^{-58}$ erg. cm^3). Still more general kinds of interactions which might appear at high energies are mentioned. W. J. SWIATECKI

539.165

7516. Secondary electron spectrum of Pr^{142}. E. N. Jensen, L. J. Laslett and D. J. Zaffarano. Letter in *Phys. Rev.*, **86**, 1047–8 (*June* 15, 1952).

Experiments are reported which confirm some earlier measurements [Abstr. 2943 (1951)] and their interpretation. J. J. WILKINS

539.165

7517. The β-spectrum of RaD. A. A. Jaffe and S. G. Cohen. Letter in *Phys. Rev.*, **86**, 1041–2 (*June* 15, 1952).

The radiations of RaD were examined by introducing it, as $Pb(CH_3)_4$, into a CH_4–A proportional counter. The β-spectrum has a max. at ~2·4 keV, with an end-point at 16·7 ± 1 keV, and is associated with the γ-ray of 46·7 keV. It is suggested that branching occurs in the β-decay, and that in $\lesssim 0 \cdot 10$ of the disintegrations a β-particle of $E_{max} = 55 \cdot 6$ keV is followed by a 7·8 keV γ-ray. A. O. STANESBY

539.165

7518. Double beta-decay of Sn^{124}. R. M. Pearce and E. K. Darby. Letter in *Phys. Rev.*, **86**, 1049–50 (*June* 15, 1952).

If the suggested double β-decay of Sn^{124} occurs by the more likely process of emission of 2 β-particles only (no neutrinos) the combined energy of the 2 β-particles must be constant; a scintillation counter was set up to give the "total energy" spectrum of the Sb^{124} radiation, but no peak was found. The lower limit of the ½-life of the process is estimated as $3\text{–}6 \times 10^{16}$ yr. A. O. STANESBY

539.165

7519. Nucleon-lepton interaction in β-decay. R. Nataf and R. Bouchez. Letter in *Phys. Rev.*, **87**, 155 (*July* 1, 1952).

Good agreement with experimental *ft* values is obtained in the case of mirror nuclei β-transitions with an interaction of the type $H_\beta = C_t H_t + C_f H_f$ (where H_t is either tensor or axial vector, H_f scalar or polar vector), with $|C_t|^2 \sim 0 \cdot 80$, $|C_f|^2 \sim 0 \cdot 20$.

A. O. STANESBY

539.165 : 539.166

7520. Beta-spectra and internal conversion coefficients for Co^{60}, Nb^{95}, Au^{198}, and Hf^{181}. C.-Y. Fan. *Phys. Rev.*, **87**, 252–62 (*July* 15, 1952).

Using a double-lens β-ray spectrometer, the β-spectra and the internal conversion coefficients for Co^{60}, Nb^{95}, Au^{198} and Hf^{181} were investigated. All the β-spectra were found to be of allowed shape with end-point energies 0·306 ± 0·005 MeV, 0·160 ± 0·003 MeV, 0·97 ± 0·01 MeV and 0·408 ± 0·008 MeV, respectively. The extra activity presented in Au^{198} was identified as Au^{199}, and the slow neutron absorption cross-section of Au^{198} was estimated to be about 10^5 barns. The internal conversion coefficients indicate that both of the γ-rays from Co^{60} are E–2^2 radiations; the 0·77-MeV γ-ray from Nb^{95} is either an M–2^2 or an E–2^2 radiation or a mixture of both; the 0·411-MeV γ-ray from Au^{198} is an E–2^2 radiation; the 0·474–MeV γ-ray from Hf^{181} is an E–2^2 radiation, the 0·134-MeV and 0·340-MeV γ-rays are M–2^1 radiations and the 0·130-MeV γ-ray is doubtful but seems to be an E–2^2 radiation. The results are discussed from the point of view of the β-decay theory and the shell structure model (Mayer, Haxel, Jensen and Suess). A.

539.165.08

7521. Applications of nuclear emulsions in the measurement of β-ray spectra. I. Preliminary results on β-activity of rubidium. A. Bonetti. *Bull. Cent. Phys. Nucléaire Bruxelles*, *No.* 19, 3 *pp.* (*May*, 1950).

The preliminary results show that for energies

between 20 and 200 keV, nuclear emulsions (Ilford G5) are useful for the evaluation of the upper energy-limit of β-spectra. A. O. STANESBY

539.165.08

7522. Backscattering of beta rays in windowless G–M counters. D. CHRISTIAN, W. W. DUNNING AND D. S. MARTIN, JR. *Nucleonics*, **10**, 41–3 (*May*, 1952).

Thin deposits of a number of β-emitters (Ni^{63}, S^{35}, Co^{60} and P^{32}) were placed over backscattering materials of widely varying Z (Be, Mg, Al, Ni, Cu, Ag, Ta and Pt), thick enough to give saturation backscattering, and a comparison of counting rates in a 2π windowless G.M. counter was made. The counting efficiency for zero backscattering was assumed to be $\frac{1}{2}$, and the efficiencies with the various backing materials determined from the counting rates and measured absolute disintegration rates. Curves of the counting efficiency v. atomic number were plotted for each β-emitter. A maximum efficiency of 75–80% was obtained with high Z. L. R. SHEPHERD

539.165.08

7523. Interaction of phosphorus-32 beta rays with matter. G. L. BROWNELL. *Nucleonics*, **10**, 30–5 (*June*, 1952).

Measurements were made in a 180° β-spectrometer to determine the effect on the β-spectrum of placing backscattering materials behind and absorbing materials in front of a P^{32} source, mounted on thin collodion. The materials used, included Lucite, Al, Cu, Sn and Pt and the observations were made on β-rays emitted at various angles to the normal to the plane of the source (from 0° to 70°). Apart from an initial increase in the case of high Z absorbers the average energy of the β-particles was observed to decrease with increase of absorber thickness and the angular distribution was observed to change from isotropic to a cos θ form. The intensity and average energy of the backscattered spectrum increased with Z and appeared to vary from an isotropic distribution for Lucite to cos θ for a high Z backscatterer. The results are examined on the basis of multiple scattering theory. L. R. SHEPHERD

539.166

7524. On the intensities of γ-rays of RaC. S. KAGEYAMA. *J. Phys. Soc. Japan*, **7**, 93–8 (*Jan.–Feb.*, 1952).

These were investigated with a semi-circular focusing magnetic spectrometer and coincidence technique of G.M. counters. The efficiencies of thick radiator for γ-rays of various energies were calculated according to the experimental straggling curves obtained by White and Millington and also taking the scattering losses into consideration. And the intensities of γ-rays were determined from the maximum heights of momentum distribution curve of Compton recoil electrons projected from a thick target of Al. From these values and the relative intensities of conversion electrons reported previously [Abstr. 3733 (1951)], the internal conversion coefficients were calculated and compared with the results of former authors and with theoretical values. Both the intensities of γ-rays of RaC and the internal conversion coefficients obtained are in accord with the results of Ellis and Aston. A.

539.166

7525. Some directional correlation functions for successive nuclear radiations. F. G. HESS. *Canad. J. Phys.*, **30**, 130–46 (*March*, 1952).

A method of evaluating the sums of angular momentum coefficients appearing in the directional correlation function for successive nuclear radiations is presented. The sums are evaluated for the simplest cases and α-γ and γ-γ correlation functions are calculated for these cases—the angular momentum quantum number of one of the emitted particles being arbitrary and that of the other being 1 or 2. A.

539.166

7526. On the γ- and X-radiations emitted by polonium 210. M. RIOU. Letter in *J. Phys. Radium*, **13**, 244 (*April*, 1952) *In French*.

The radiations were examined using a Xe-filled G.M. counter, or a Pb-wall counter, with selective absorbers. The presence of Pb K and L X-rays was confirmed; the K-radiation is due to internal conversion of the 800-keV γ-ray, the L-radiation to excitation of the Pb atoms present by the α-particles emitted. A. O. STANESBY

539.166

7527. Angular distribution and polarization of gamma radiation emitted by aligned radioactive nuclei. H. A. TOLHOEK AND J. A. M. COX. Letter in *Physica*, **18**, 357–8 (*May*, 1952).

Theoretical results for electric dipole and quadrupole radiation are given, valid for any degree of alignment. The cases of a preceding β-transition $j \to j-1$, or γ-transition $j \to j-2$ are included.

J. J. WILKINS

539.166

7528. The angular correlation of two gamma quanta emitted by aligned radioactive nuclei. J. A. M. COX and H. A. TOLHOEK. Letter in *Physica*, **18**, 359–60 (*May*, 1952).

See preceding abstract. Theoretical correlation functions for dipole-dipole and for Co^{60} radiation are given. The general conditions under which total alignment gives zero correlation are stated.

J. J. WILKINS

539.166.08 : 537.542

7529. Measurement of cesium-137 and cobalt-60 gamma radiation with a pressure ionization chamber. G. R. GROVE. *J. Res. Nat. Bur. Stand.* [*Wash.*] **48**, 147–51 (*Feb.*, 1952).

The characteristics of the pressure ionization chamber at the National Bureau of Standards have been studied for the γ-radiation from a Cs^{137} source (0·6614 MeV) and from a Co^{60} source (1·1715 and 1·3316 MeV). The dosage rates produced in air by these sources were measured with this chamber with an accuracy of about 2%. Dosage rates obtained with an extrapolation chamber and a Victoreen thimble chamber agreed with the values measured by the pressure chamber within the limits of the experimental errors. A.

539.166.75

7530. Absorption coefficients of gamma-rays. S. J. WYARD. Letter in *Phys. Rev.*, **87**, 165 (*July* 1, 1952).

Coefficients for H_2O, C, Al, Cu, Mo, Ag, W, Pb

and U have been measured for 0·28- to 1·51-MeV γ-rays. The values found for W, Pb and U were about 2% less than calculated values at the higher energies.

J. J. WILKINS

539.166.83

7531. Internal conversion in Cu^{64} and Fe^{59}. D. BROWER, G. HINMAN, G. LANG, R. LEAMER AND D. ROSE. Letter in *Phys. Rev.*, **86**, 1054–5 (*June* 15, 1952).

K-conversion coefficients were measured for the 1·34-MeV Cu^{64} γ-ray and the 1·11- and 1·30-MeV Fe^{59} γ-rays. The results were (1·0–1·6), (1·45 ± 0·05) and (0·84 ± 0·05), all $\times 10^{-4}$, respectively.

J. J. WILKINS

539.166.835

7532. Internal conversion of γ-rays with pair production. S. A. S. BRIMBERG. Letter in *Phys. Rev.*, **87**, 150–1 (*July* 1, 1952).

A numerical calculation of the internal pair formation coefficient for dipole and quadrupole γ-ray energy 1·31 MeV and $Z = 28$ based on the "exact" treatment of Jaeger and Hulme (1935). W. J. SWIATECKI

539.166.835

7533. Differential cross section for bremsstrahlung and pair production. L. C. MAXIMON AND H. A. BETHE. Letter in *Phys. Rev.*, **87**, 156 (*July* 1, 1952).

A formula is given for the limit of high relativistic energies without the use of Born approximation.

W. J. SWIATECKI

539.166.835

7534. Integral cross section for bremsstrahlung and pair production. H. DAVIES AND H. A. BETHE. Letter in *Phys. Rev.*, **87**, 156–7 (*July* 1, 1952).

The formula of the preceding abstract was integrated over angles. The exact treatment results in complete agreement with experiment. W. J. SWIATECKI

NUCLEAR REACTIONS 539.17

539.17 : 778.3

7535. A device for marking event positions on the surface of nuclear emulsions. E. W. TITTERTON AND W. BARNEVELD. *J. Sci. Instrum.*, **29**, 250–1 (*Aug.*, 1952).

A description is given of a device which scribes a circle of chosen diameter on the surface of a nuclear emulsion above a particular event. The circles so marked can be seen with the naked eye in reflected light and greatly facilitate re-examination of an event.

A.

539.17 : 778.3

7536. Photo-electric determination of the density of tracks in nuclear emulsions. S. VON FRIESEN AND K. KRISTIANSSON. *Ark. Fys.*, **4**, 505–15 (*Paper* 35, 1952).

The experimental arrangements for the photo-electric measurement of the grain density of tracks due to particles of high ionizing power are described in detail. For tracks having a residual range of 400 microns, it has been found possible to distinguish π from μ mesons. Protons, deuterons and tritons can only be identified with certainty over this short track length provided the variation of track density with depth of the emulsion is taken into account. If the grain density of a track is less than 4× the density at minimum ionization ordinary grain counting is found to be superior to the photoelectric method. A. C. COATES

539.17 : 778.34

Tracks in nuclear emulsions from radioactive contamination *See Abstr.* 7859

539.172

7537. Sum rules in the dispersion theory of nuclear reactions. T. TEICHMANN AND E. P. WIGNER. *Phys. Rev.*, **87**, 123–35 (*July* 1, 1952).

The dispersion theory is developed with an internal region V whose boundary S is quite close to the nuclear surface. Two types of quantities then occur: those like the derivative matrix R, which connect the values and derivatives of the wave function at S, and those like the collision matrix U which give the asymptotic behaviour of the wave function. These latter are, of course, independent of the position of S. Because of the proximity of S to the nuclear surface, the wave function in the closed channels and its derivative remain appreciable at S. They may, however, be eliminated from the formalism leading to a reduced R which connects the values and derivatives of the wave function in the open channels only. This reduced R is used to obtain expressions for the S-independent quantities, in particular, for the collision matrix. These expressions are given more explicit, but approximate form. The development shows that the quantity, which in the usual formulae for the cross sections is interpreted as the nuclear radius, need not be equal to this at all, but is the distance at which two opposite effects compensate. Exact expressions are given for the poles and residues of some S-independent quantities, which are then compared with the poles and residues of the approximate expressions of the previous chapter. In this way criteria are derived for the accuracy of these approximate expressions. Finally two sum rules are derived for the parameters in the original R. The consequences of these sum rules are traced for the reduced R and for the S-independent quantities, in the light of the development of the earlier sections. The first sum rule gives a maximum for the partial widths of levels, while the second leads to the well-known proportionality of reduced level width and level spacing. The meaning and validity of this is discussed in some detail, both for the single-particle and many-particle pictures. A.

539.172

7538. The effect of atomic binding on nuclear reaction energies. R. SERBER AND H. S. SNYDER. Letter in *Phys. Rev.*, **87**, 152–3 (*July* 1, 1952).

The change in the atomic energy due to instantaneous or adiabatic changes in Z is derived and illustrated by means of the Thomas–Fermi model.

W. J. SWIATECKI

539.172

7539. Selection rules in nuclear reactions. A. GAMBA, R. MALVANO AND L. A. RADICATI. *Phys. Rev.*, **87**, 440–3 (*Aug.* 1, 1952).

The symmetry properties of nuclear wave functions

and Hamiltonian operators with respect to the symmetric permutation group are discussed in order to get selection rules for the decay of a nucleus after absorption of an electromagnetic or mesonic radiation. As an illustrative example of the method a simple case of photodisintegration of the α-particle was studied. A.

539.172 : 537.591.8

Nuclear reactions due to cosmic rays. *See Abstr.* 7379–86

539.172 : 537.591.8

A note on Janossy's mathematical model of a nuclear cascade. *See Abstr.* 7386

539.172.11

7540. Investigations on the angular distributions of protons from the $Al^{27}(\alpha, p)Si^{30}$ reaction. R. R. Roy, J. Quéquin and P. Janssens. *Bull. Cent. Phys. Nucléaire Bruxelles, No.* 31, 9 *pp.* (*July*, 1951).

A polonium source and nuclear emulsion detectors were employed. 4·0-MeV incident α-particles yielded isotropic protons for the ground-state transition ($Q = 2{\cdot}26 \pm 0{\cdot}05$ MeV) and maxima at 43° and 137° for the first excited state $Q = -0{\cdot}02 \pm 0{\cdot}06$ MeV). 4·44 MeV α-particles gave maxima at 50° and 130° (ground-state) and at <27° and >153° (first excited state). J. J. WILKINS

539.172.13

7541. The angular distributions of the gamma rays in the reaction $^{19}F(p, \alpha\gamma)^{16}O$. J. E. Sanders. *Phil. Mag.*, **43**, 630–1 (*June*, 1952).

These were measured for the 6·14 MeV and the combined 6·91 and 7·11 MeV rays from the 874 keV resonance using a deuterium-filled ionization chamber as a γ-ray spectrometer. The levels involved can be assigned the following spins and parities: 2^- in F^{19} and 3^-, 2^+ and 2^- in O^{16}. W. J. SWIATECKI

539.172.13

7542. Gamma-ray angular correlation for proton bombardment of boron. G. M. Lewis. Letter in *Phil. Mag.*, **43**, 690–2 (*June*, 1952).

The correlation of the cascading 4 and 12 MeV γ's from the reaction $B^{11}(p, \gamma)C^{12}$ emitted at 90° to the beam was found to be $1 + (0{\cdot}38 \pm 0{\cdot}06)\cos^2\theta$ using scintillation counters. W. J. SWIATECKI

539.172.13

7543. Excitation in high energy nuclear reactions. N. M. Hintz. Letter in *Phys. Rev.*, **86**, 1042–3 (*June* 15, 1952).

Direct evidence for non-capture excitation in $Al^{27}(p, 3pn)Na^{24}$ and $C^{12}(p, pn)C^{11}$ was obtained by measuring the range of the struck nucleus in the target foil as given by the fraction of active residual nuclei knocked out of the foil by 20–100 MeV protons. W. J. SWIATECKI

539.172.13

7544. Proton-proton collisions within lithium nuclei. O. Chamberlain and E. Segrè. *Phys. Rev.*, **87**, 81–3 (*July* 1, 1952).

When lithium is bombarded by 350 MeV protons, one frequently observes pairs of protons emitted in coincidence at approximately 90° to each other. These protons are most easily interpreted as the result of the scattering of the primary protons on free protons in the lithium nucleus. Assuming a model of free nucleons in the nucleus, it is possible to calculate the angular correlation and the intensity of this scattering process. The present experimental results are quite consistent with this picture, if one assumes the distribution of momentum corresponding to a Fermi gas in the nucleus. A.

539.172.13

7545. Nuclear reactions of iron with 340-MeV protons. G. Rudstam, P. C. Stevenson and R. L. Folger. *Phys. Rev.*, **87**, 358–65 (*July* 15, 1952).

Natural Fe was bombarded with the full energy proton beam of the Berkeley 184 in synchrocyclotron, and a number of radioactive spallation products were isolated and identified and their formation cross-sections measured against that of the reaction $Al^{27}(p, 3pn)Na^{24}$. A simple mechanism was postulated to account for the observed product yields. A new isotope of Cr, assigned to mass 48, was observed and partially characterized. A.

539.172.13

7546. The scattering of protons from carbon. P. A. Wolff. *Phys. Rev.*, **87**, 434–8 (*Aug.* 1, 1952).

Using the impulse approximation, a formula has been derived which gives the energy spectra of protons scattered from C in terms of the nuclear momentum distribution. Estimates of the errors involved in this formula give values of 5–10% for a 340 MeV bombarding energy. A comparison is made with the experimental data of Cladis and it is concluded that a Gaussian momentum distribution gives a good fit to his results. A.

539.172.13

7547. Angular correlation between protons and gammas in the $Li^6(d, p\gamma)Li^7$ reaction. W. H. Burke and J. R. Risser. *Phys. Rev.*, **87**, 294–6 (*July* 15, 1952).

This was experimentally determined for the purpose of obtaining information on the 480 keV excited state of Li^7. A bombarding energy of 500 keV was used so that the Be^{8*} intermediate nucleus would be formed in the 22·5 MeV excited state reported by Whaling and Bonner. No correlation was observed within the statistical accuracy of the experiment. A.

539.172.11

7548. Excited states of Mg^{25} from the $Al^{27}(d, \alpha)Mg^{25}$ and $Mg^{24}(d, p)Mg^{25}$ reactions. P. M. Endt, H. A. Enge, J. Haffner and W. W. Buechner. *Phys. Rev.*, **87**, 27–30 (*July* 1, 1952).

The α-particle groups from thin aluminium targets bombarded with 1·8, 2·0 and 2·1 MeV deuterons have been studied with a high resolution magnetic spectrograph. Eleven of these groups have been assigned to the $Al^{27}(d, \alpha)Mg^{25}$ reaction, corresponding to the ground state and ten excited states of Mg^{25} in a region of excitation from zero to 4·0 MeV. The proton groups from a thin natural Mg target were also studied at deuteron bombarding energies of 1·5, 1·8 and 2·0 MeV. Eleven of the observed proton groups could be assigned to the $Mg^{24}(d, p)Mg^{25}$ reaction, corresponding to the transition to the ground state of Mg^{25} and the same ten excited levels found from the $Al^{27}(d, \alpha)Mg^{25}$ reaction. The excited states in Mg^{25} found from these two reactions are at 0·583, 0·976, 1·611, 1·957, 2·562, 2·736, 2·799, 3·405, 3·89 and 3·969 MeV.

539.172.13

7549. Investigation of the (d, p) and (d, α) reactions of the silicon isotopes. D. M. VAN PATTER AND W. W. BUECHNER. *Phys. Rev.*, **87**, 51–9 (*July* 1, 1952).

An investigation of the $Si^{29}(d, \alpha)Al^{27}$, $Si^{29}(d, p)Si^{30}$ and $Si^{30}(d, p)Si^{31}$ reactions was made using a high-resolution magnetic spectrograph. The spectra of particle groups observed at 90 degrees to the incident deuteron beam from silicon-dioxide targets enriched in Si^{29} and Si^{30} were compared to the spectra obtained from targets of natural SiO_2. The Q-values for the ground-state transitions are $5{\cdot}994 \pm 0{\cdot}011$, $8{\cdot}388 \pm 0{\cdot}013$ and $4{\cdot}364 \pm 0{\cdot}007$ MeV. The following level positions were determined: Al^{27}: 0·84 and 1·01 MeV; Si^{30}: 2·24, 3·51 and 3·79 MeV; Si^{31}: 0·757, 1·699, 2·319, 2·751, 3·140, 3·539 and 4·384 MeV. In addition a survey of the $Si^{28}(d, p)Si^{29}$ reaction to lower proton energies indicated levels in Si^{29} at 5·946, 6·105 and 6·380 MeV. A.

539.172.13

7550. The angular distribution and excitation function of the long-range protons from the $Be^9(d, p)Be^{10}$ reaction. F. L. CANAVAN. *Phys. Rev.*, **87**, 136–40 (*July* 1, 1952).

The angular distribution of the long-range protons from the deuteron bombardment of Be^9 has been investigated over the deuteron energy range from 1·0 to 2·2 MeV using a photographic technique. The excitation function has been measured from 0·55 to 2·95 MeV using a proportional counter. On the basis of a compound nucleus model, the fact that six terms are required to fit the observed distributions with a series of Legendre polynomials indicates the presence of overlapping levels of the compound nucleus in the region with both even and odd parities, and that both d and f deuterons enter into the reaction at these energies. There is, however, some evidence that the reaction proceeds in part by a stripping process with the transfer of a neutron with $l = 1$ to the target nucleus. This stripping becomes relatively more important as the deuteron energy is increased. The excitation function shows evidence of broad, overlapping resonances. A.

539.172.13

7551. Angular correlations in the $Li^6(d, p)Li^{7*}(\gamma)Li^7$ reaction. C. M. CLASS AND S. S. HANNA. *Phys. Rev.*, **87**, 247–51 (*July* 15, 1952).

The yield of radiation in the $Li^6(d, p)Li^{7*}(\gamma)Li^7$ reaction has been measured as a function of angle in correlation with protons observed in the direction of beam and with the beam alone. No anisotropy was detected in either observation. The only plausible theoretical explanation of these results is the assignment of $I = 1/2$ to the first excited state of Li^7 in agreement with other recent observations. A.

539.172.3

7552. (γ, α) reactions on Li^7, O^{16}, and $Br^{79, 81}$. H. NABHOLZ, P. STOLL AND H. WÄFFLER. Letter in *Phys. Rev.*, **86**, 1043–4 (*June* 15, 1952).

The cross-sections were measured by analysing α-particle tracks in emulsions. The angular distribution of the tritons was measured. The energy spectrum of the α's from Br is consistent with statistical model calculations. W. J. SWIATECKI

539.172.3

7553. High energy photodisintegration of the deuteron. R. LITTAUER AND J. KECK. Letter in *Phys. Rev.*, **86**, 1051–2 (*June* 15, 1952).

Using H_2O and D_2O targets and a proton counter telescope a cross-section of $\sim 0{\cdot}05$ mb was found for 260 MeV γ-rays and $\sim 20\%$ less for 180 MeV γ-rays. No significant ($< 50\%$) deviations from isotropy were detected. J. J. WILKINS

539.172.3

7554. Photodisintegration of the deuteron at high energies. B. BRUNO AND S. DEPKEN. Letter in *Phys. Rev.*, **86**, 1054 (*June* 15, 1952).

Cross-section calculations have been made assuming that a (pseudoscalar) π-meson is emitted by one nucleon, absorbs the photon, and is then absorbed by the other nucleon. Pseudovector (but not pseudoscalar) coupling gives reasonable agreement with experiment. J. J. WILKINS

539.172.3

7555. Angular distributions of photoprotons. A. K. MANN, J. HALPERN AND M. ROTHMAN. *Phys. Rev.*, **87**, 146–9 (*July* 1, 1952).

The angular distribution of photoprotons from Cu, Ni and Co targets irradiated with bremsstrahlung of 23 MeV maximum energy have been measured. Protons from Cu and Co show a large asymmetric component which is described by the expression $(\sin\theta + 0{\cdot}5 \sin\theta \cos\theta)^2$. Absorption experiments on the protons are consistent with the assignment of the asymmetric component to transitions involving discrete levels in the vicinity of the ground state of the residual nucleus. The angular distributions observed are interpreted as resulting from interference between electric dipole and quadrupole absorption of the initial photons with the relative quadrupole intensity equal to 5%. A.

539.172.3

7556. Angular distribution of photoprotons from carbon. J. HALPERN, A. K. MANN AND M. ROTHMAN. Letter in *Phys. Rev.*, **87**, 164–5 (*July* 1, 1952).

Bremsstrahlung of 23 MeV maximum energy gave a distribution strongly peaked at about 80°. It is attributed to predominant dipole absorption plus about 1% quadrupole absorption. J. J. WILKINS

539.172.4

7557. Energy dependence of the capture cross sections of Ag, Cu and Al for fast neutrons. S. YAMABE, M. NOZAWA AND J. SANADA. *J. Phys. Soc. Japan*, **7**, 140–3 (*March–April*, 1952).

Relative cross-sections of Ag^{107}, Cu^{63} and Al^{27} for radiative capture of neutrons were determined at energies from 2·3 MeV to 3·1 MeV by the method of observing the induced activity. For Ag^{107} and Cu^{63}, capture cross-sections decreased almost as $1/E$, where E is the energy of neutrons. For Al^{27}, deviation from monotonous decrease was found. This seemed to be caused by the resonance effects, which had been observed in the measurements of the total cross-section for Al. Cross-section of the (n, p) reaction for Al^{27} was estimated at 3 MeV and was found to be of about the same order of magnitude as that of the (n, γ) reaction. A.

539.172.4

7558. On the excitation of gamma-rays by fast neutrons. T. WAKATSUKI AND K. SUGIMOTO. *J. Phys. Soc. Japan*, 7, 249–56 (*May–June*, 1952).

Fluorescent γ-rays from 32 elements excited by Li-D neutrons were observed by Al-wall Geiger-Müller counter. Effective mean neutron energy was estimated to be about 10 MeV. Observed γ-ray intensities, after correcting for experimental conditions and divided by the number of atoms in the specimens, increase almost linearly with atomic weight A up to $A \simeq 120$ and then become almost constant or slightly decrease at heavier elements. Gamma-ray intensity of U is strong but would be ascribed to fission. These results were discussed utilizing statistical theory and it is suggested that the apparent level spacings beyond $A \simeq 120$ do not decrease with A, or even become greater, possibly due to the partial excitation of the nucleus. Mean energies of γ-rays for several elements were estimated by the absorption in Pb plates and were found to lie between 0·6 and 3 MeV. A.

539.172.4

7559. Slow neutron resonances in In^{113} and In^{115}. V. L. SAILOR AND L. B. BORST. Letter in *Phys. Rev.*, **87**, 161–2 (*July* 1, 1952).

Five resonances in In^{115} and 4 in In^{113} in the range 1–50 eV were studied using a Be crystal spectrometer. W. J. SWIATECKI

539.172.4 : 537.542

Ionization measurement of $B^{10}(n, \alpha)Li^7$. *See Abstr.* 7348

539.172.4

7560. The measurement of the ratio of effective fission cross-sections for thermal neutrons from Pu^{239} and natural uranium. R. COHEN, E. COTTON AND A. LÉVÊQUE. *C.R. Acad. Sci.* [*Paris*] **234**, 2355–7 (*June* 9, 1952) *In French.*

Thin layers of the two substances on Pt were placed back-to-back in a double ionization chamber in a pile-neutron beam. The ratio found was $203{\cdot}3 \pm 4{\cdot}0$, giving the Pu cross-section at 0·025 eV as 796 ± 16 barns. F. R. HOLT

539.172.4

7561. Spontaneous fission of U^{234}, Pu^{236}, Cm^{240} and Cm^{244}. A. GHIORSO, G. H. HIGGINS, A. E. LARSH, G. T. SEABORG AND S. G. THOMPSON. Letter in *Phys. Rev.*, **87**, 163–4 (*July* 1, 1952).

U^{234} was obtained by electromagnetic separation, Pu^{236} by 18 MeV deuteron bombardment of U^{235}, Cm^{240} by the reaction $Pu^{239}(\alpha, 3n)Cm^{240}$ with 38 MeV He ions and Cm^{244} by β-decay of Am^{244} formed in pile neutron irradiation of Am^{243}. Chemically purified samples were examined in an ionization chamber and the half-lives against spontaneous fission were found to be 2 ± 10^{16} yr, $3{\cdot}5 \pm 1 \times 10^9$ yr, $1{\cdot}9 \pm 0{\cdot}4 \times 10^6$ yr and $1{\cdot}4 \pm 0{\cdot}2 \times 10^7$ yr, respectively. Except for the case of U^{234}, the simple exponential dependence of the half-lives on Z^2/A, previously reported, is followed. L. R. SHEPHERD

539.172.4

7562. Velocities of fragments from fission of U^{233}, U^{235}, and Pu^{239}. R. B. LEACHMAN. *Phys. Rev.*, **87**, 444–7 (*Aug.* 1, 1952).

The velocity distributions of fragments from slow neutron induced fission have been measured by a time-of-flight method. When compared with data from fission fragments stopped in ionization chambers filled with A and CO_2, these velocity data indicate that the kinetic energies of the fragments exceed those reported by ionization chamber measurements by 5·7 MeV for the most probable light fragment and by 6·7 MeV for the most probable heavy fragment. These energy differences, for the most probable light and heavy fragments, can be explained by energy-ionization ratios which exceed by 6% and 11%, respectively, the α-particle energy-ionization ratio on which the energies from ionization chamber measurements are based. The average kinetic energy of fission fragments determined from velocities is shown to be in good agreement with calorimeter results and the energy calculated from recent mass spectrographic data. The widths of the peaks of the directly measured velocity distribution, for which the resolution is known, are appreciably narrower than those calculated from ionization chamber data. These differences in width are used to estimate the resolution of ionization chamber measurements of fission fragment energies. A.

539.172.4 : 539.152.1

7563. Fission product yields and shell structure in atomic nuclei. H. G. THODE. *Trans Roy. Soc. Can.*, **45**, 1–17 (*June*, 1951).

Evidence, based upon fission product yields in thermal neutron induced and spontaneous fission, for the existence of closed shells of 50 and 82 neutrons in atomic nuclei, is reviewed briefly. L. R. SHEPHERD

ATOM AND MOLECULE BEAMS . MESONS NEUTRONS 539.18

539.18

7564. On collisions of π-mesons with deuterons. V. B. BERESTETSKIĬ AND I. YA. POMERANCHUK. *Dokl. Akad. Nauk SSSR*, **81**, 1019–21 (*No.* 6, 1951) *In Russian.*

Information on the nature of the coupling of π-mesons to nuclei (especially the spin dependence) can be inferred from a comparison of ordinary and charge exchange scattering on H and D (with or without parity change). Using a semi-phenomenological method the relations between corresponding cross-sections in H and D are deduced. W. J. SWIATECKI

539.18

7565. On the transformation of a charged π-meson into a neutral meson in a collision with a proton or a deuteron. V. B. BERESTETSKIĬ AND I. YA. POMERANCHUK. *Zh. Eksper. Teor. Fiz.*, **21**, 1313–20 (*No.* 12, 1951) *In Russian.*

The cross-sections for the process are calculated for ps. scalar mesons with ps. scalar, ps. vector or "mixed" coupling and the energy dependence is found to discriminate well between these cases. The angular distribution should provide a test of the assumption of the same parity for $\pi^{\pm}$ and π^0. W. J. SWIATECKI

539.18

7566. The scattering of π-mesons by protons and deuterons. V. B. Berestetskiĭ and I. M. Shmushkevich. *Zh. Eksper. Teor. Fiz.*, **21**, 1321–9 (*No.* 12, 1951) *In Russian.*

Detailed calculations of cross-sections for ps. scalar and ps. vector couplings. The former gives values so much in excess of $\pi(\hbar/\mu c)^2$ that the internal consistency of the theory with perturbation treatment in this case is in doubt. W. J. SWIATECKI

539.18

7567. On the determination of the spin of charged π-mesons. I. M. Shmushkevich. Letter in *Zh. Eksper. Teor. Fiz.*, **22**, 251–3 (*No.* 2, 1952) *In Russian.*

The principle of detailed balancing gives for the ratio of $\sigma[(p \text{ or } n) + d \rightarrow (H^3 \text{ or } He^3) + \pi^{+\text{ or }-}]$ to its reverse the value $[(2s+1)/3]$ (meson momentum/deutron momentum)^2 from which s can be determined. W. J. SWIATECKI

539.18

7568. Angular distribution of 53-MeV positive pions scattered by protons. E. C. Fowler, W. B. Fowler, R. P. Shutt, A. M. Thorndike and W. L. Whittemore. Letter in *Phys. Rev.*, **86**, 1053–4 (*June* 15, 1952).

An analysis of 967 cloud chamber photographs of π–μ decays in H_2, in which 21 scatterings were observed leads to a cross-section of 20 ± 4 mb at 53 ± 10 MeV and a non-isotropic angular distribution, both consistent with the Chicago results [Anderson, Fermi *et al.* (1952)]. W. J. SWIATECKI

539.18

7569. Production of 40-MeV π^+ and π^- mesons in seven elements by 240-MeV protons. D. L. Clark. Letter in *Phys. Rev.*, **87**, 157–8 (*July* 1, 1952).

Be, C, Al, Cu, Ag, W and Pb targets were bombarded by the internal synchro-cyclotron beam and cross-sections were measured in the range 130°–150° for π^+ and 30°–50° for π^-. An $A^{2/3}$ dependence was not confirmed. W. J. SWIATECKI

539.18

7570. Decay of a neutral scalar heavy meson. H. P. Noyes. *Phys. Rev.*, **87**, 344–51 (*July* 15, 1952).

The decay of a neutral scalar heavy meson into two pseudoscalar π-mesons is renormalized by the introduction of a contact interaction $\chi\Phi_s\phi_{ps}{}^*\phi_{ps}(x)$, where the finite part of χ is an empirical constant chosen to fit the observed lifetime for this decay. This interaction contributes to the decay into two γ-rays in order $G_s g_{ps}{}^2 e$, and all contributions to this order have been calculated. The total 5th-order contribution is negative relative to the 3rd-order matrix element. Consequently, for a particular relationship between the heavy and light meson coupling constants, the 2γ decay lifetime will be e^4/g^4 slower than the 2π decay lifetime. Hence, heavy scalar mesons strongly enough coupled to nucleons to be produced copiously at high energies could be sufficiently stable to be observed experimentally; in particular the V_2^0 particle may be of this type. A.

539.18

7571. The relative specific ionization of fast mesons. R. S. Carter and W. L. Whittemore. *Phys. Rev.*, **87**, 494–8 (*Aug.* 1, 1952).

An experiment has been performed with cosmic-ray mesons to study the specific ionization in the relativistic region. A cloud chamber was used to measure the rate of droplet production for two groups of mesons, one with momentum p between 70 and 250 MeV/c and the other with $p > 1500$ MeV/c. These two groups of momenta were selected by the appropriate arrangement of Geiger counters. The cloud chamber used to measure the ionization was also used to measure the magnetic rigidity of the particles in the lower group of momenta. The particles in the other group produced tracks which were essentially straight in the magnetic field of 4800 gauss. The group of mesons with lower momenta ionized at or near the minimum rate which was determined to be $14{\cdot}7 \pm 0{\cdot}35$ droplets/mm on the photographic film. The other group of mesons gave an experimental average of $17{\cdot}9 \pm 0{\cdot}25$ droplets/mm, in good agreement with the value of 18·5 droplets/mm predicted on the basis of the Bethe–Bloch ionization theory and the accepted momentum spectrum for sea-level cosmic-ray mesons. The good agreement obtained between the experimental and theoretical distributions shows that the present ionization theory with its rise in the relativistic region adequately describes the observed rate of energy loss for energetic mesons with values of p/μ up to approximately 100. Too few mesons were available with momenta large enough to check the effect of polarization in He. A.

539.181

7572. The determination of the polarizability of atoms and molecules by means of the field electron microscope. M. Drechsler and E. W. Müller. *Z. Phys.*, **132**, 195–211 (*No.* 2, 1952) *In German.*

A monocrystalline needle-like W cathode of a field electron microscope is irradiated from one side by a molecular beam which is bent round in the strongly inhomogeneous electrostatic field near the tip and so "illuminates" part of the tip which would otherwise be in the shadow. By studying this shadowing as a function of the cathode potential as revealed subsequently by taking a photograph of the emission from the cathode tip on a fluorescent screen, one can deduce the polarizability of the initial molecular beam. A numerical integration of the equations of motion of the beam molecules in an idealized field representing the neighbourhood of the tip gave results accurate to $\sim 20\%$ for Ba, H, Li, Cs and Cu-phthalocyanin molecules. W. J. SWIATECKI

539.185

7573. Backward scattering of D–D neutrons. S. Yamabe and J. Sanada. *J. Phys. Soc. Japan*, **7**, 136–9 (*March–April*, 1952).

Backward scattering cross-sections of 3·1 MeV neutrons scattered by C. O. Fe, Cu and Pb were obtained at angles between 130° and 160° in the laboratory system, assuming that the scattering was entirely elastic. The detector used was a methane-filled ionization chamber connected to electrometer.

For C and Pb, differential cross-sections increase at large scattering angle, but there is no deviation from flat distribution for other elements. In the case of C it seems to be reasonable to assume that the scattering is entirely elastic, and, taking into account previous results on the forward distribution, the whole angular distribution in the centre of mass system can be represented as: $\sigma(\theta) = (6{\cdot}8 + 6{\cdot}0\cos\theta + 23\cos^2\theta) \times 10^{-26}$ cm^2. But in the case of Pb this backward rising cannot be ascribed to the elastic scattering alone because there may be some contribution from the inelastically scattered neutrons for which the detector used has a different efficiency. A.

539.185

7574. Analysis of 14-MeV *n–p* scattering. G. Snow. *Phys. Rev.*, **87**, 21–6 (*July* 1, 1952).

The total *n–p* cross-section at $14{\cdot}10 \pm 0{\cdot}05$ MeV is calculated for several choices of the *n–p* singlet potential well parameters for each of the potential well shapes: square, exponential and Yukawa. These calculations are compared with the experimental result for the cross-section at this energy, $\sigma_{\text{total}} = 0{\cdot}689 \pm 0{\cdot}005$ barn. Limits on the values of the effective range, the intrinsic range, and the depth of the singlet potential are obtained for each well shape. Contrary to the hypothesis of charge independence of nuclear forces, the *n–p* singlet intrinsic range is found to be smaller than the *p–p* singlet intrinsic range for all three well shapes. However, the large error in the *n–p* singlet range precludes any conclusive statement to the effect that *n–p* and *p–p* intrinsic ranges are unequal. A.

539.185

7575. Neutron-proton scattering in the region 0–5 MeV. L. Hulthén and S. Skavlem. *Phys. Rev.*, **87**, 297–303 (*July* 15, 1952).

The theoretical cross-section for scattering of neutrons by protons has been calculated on the basis of a pure central Yukawa potential with the same range in ^1S and ^3S states, corresponding to meson mass 200 and 300, respectively. The results indicate that the best over-all fit with most recent scattering experiments would be obtained with a meson mass of roughly 350 m_e. Allowing different ranges in singlet and triplet states and making use of the deuteron binding energy, a "triplet mass" of 290 and a "singlet mass" of about 380 were found. A further result of this work is that, at least in the case of Yukawa potential, the "effective range" approximation is prone to give the total cross-section much more accurately than the singlet and triplet cross-sections separately. Accordingly, this approximation ought to be handled with some care in other problems than *n–p* scattering. A.

539.185

7576. Scattering by many-body systems in terms of two-body collision parameters. H. Ekstein. *Phys. Rev.*, **87**, 31–9 (*July* 1, 1952).

The scattering of a particle by a system of N particles is described without approximation by a set of equations not containing the interaction Hamiltonian, but an infinite set of two-body collision parameters which can be obtained from solving two-body problems. These equations, obtained with the assumption of two-body potential interaction between particles, can be applied to the case where the scattering particles are themselves complex systems, provided that the relevant two-body collision parameters are known or inferred from experiment. In the simplest case where the only relevant parameter is the scattering length, the first approximation is Fermi's result for the scattering of slow neutrons by protons. The "impulse approximation" is shown to be an approximate form of the present first approximation. It is shown that previous approximation schemes, in general, fail to give convergent higher approximations for the limiting case of point scatterers, whereas the present equations give convergent higher terms. It can be concluded that the latter are particularly appropriate for short-range interaction. The matrix α which contains all necessary two-body collision parameters is expressed in terms of solutions of the ordinary free two-body scattering problem. The result is applied to derive a revised theory of refraction and diffraction of slow neutrons in crystals by including the effect of zero-point motion of the nuclei and the electrostatic interaction between neutrons and electrons. A.

539.185

7577. The inelastic scattering of neutrons. W. Hauser and H. Feshbach. *Phys. Rev.*, **87**, 366–73 (*July* 15, 1952).

The total cross-section and the differential cross-section for the inelastic scattering of neutrons are considered. It is assumed that the compound nucleus is sufficiently excited so that the statistical model may be applied. If the statistical model may be applied as well to the residual nucleus, it is shown that the angular distribution of the inelastically scattered neutrons is isotropic. If only a few levels of the target nucleus can be excited, the angular distribution is anisotropic. Tables are provided which permit the calculation of the angular distribution if the incident and emergent neutron angular momenta are less than or equal to $3\hbar$. Examples of the evaluation of total cross-sections are given, providing examples of the sensitivity of the results to the quantum numbers of the excited state. A.

539.185

7578. The coherent neutron scattering cross sections of nitrogen and vanadium. S. W. Peterson and H. A. Levy. *Phys. Rev.*, **87**, 462–3 (*Aug.* 1, 1952).

Neutron diffraction measurements on vanadium nitride, vanadium carbide, and potassium azide show the coherent neutron scattering cross-section of nitrogen to be $11{\cdot}1 \pm 0{\cdot}3$ barns, positive phase and that of vanadium to be $0{\cdot}029 \pm 0{\cdot}01$ barn, negative phase. A.

539.185

7579. Slow neutron crystal spectrometry: the total cross sections of Co, Er. Hf, Ni^{58}, Ni^{60}, Ho, and fission Sm. S. Bernstein, L. B. Borst, C. P. Stanford, T. E. Stephenson and J. B. Dial. *Phys. Rev.* **87**, 487–93 (*Aug.* 1, 1952).

A focusing spectrometer using a variable curvature quartz crystal has been developed for measuring total cross-sections *v.* energy of small samples of rare

elements, separated isotopes and radioactive isotopes in the energy region 0·03 eV to about 1·5 eV. Samples having macroscopic cross-sections from 0·1 to 1·0 square millimeters have been used as absorbers. The main features of the new instrument are described, and performance curves are given. The instrument was first used to show that a sample of rare earth fission product material has a resonance at an energy corresponding to the known resonance of Sm^{149}. Test runs were made on normal Co, whose total cross-section was found to fit the formula, $\sigma(\text{barns}) = 5\cdot0 + 6\cdot1(E \text{ in eV})^{\frac{1}{2}}$. A resonance at about 1 eV, attributed in the literature to Zr, was found to belong to Hf. Er was found to have a neutron resonance at about 0·5 eV. Ni^{58} was found to be the isotope primarily responsible for the anomalously high scattering cross-section of normal Ni, confirming results from neutron diffraction studies made simultaneously by other observers. Results are given also for Ni^{60}. Analysis of the Ho measurements give a scattering cross-section that is strongly energy dependent. Paramagnetic scattering is suggested as a possible explanation of the variation. A.

539.185.08

7580. Survey methods for fast and high-energy neutrons. B. J. Moyer. *Nucleonics*, **10**, 14–19 (*May*, 1952).

Two methods are described in some detail for measurement of neutrons in the range 0·3–15 MeV. The first involves the observation of the current produced by recoil protons and carbon nuclei in a homogeneous "tissue equivalent" proportional counter, with methane filling and $(CH_2)n$ walls. Neutron flux can be determined by this method if the neutron energy spectrum is known approximately. The second method involves the measurement of current due to recoil protons from a thick hydrogeneous radiator in a proportional counter (a scintillation type of detector can also be used). This method leads to the measurement of neutron energy flux. In the case of high-energy neutrons (> 20 MeV) the measurement of stars in nuclear emulsions and the employment of bismuth fission counters (above *c.* 50 MeV) are mentioned briefly. L. R. SHEPHERD

539.185.08

7581. A fast neutron spectrometer. L. E. Beghian, R. A. Allen, J. M. Calvert and H. Halban. Letter in *Phys. Rev.*, **86**, 1044 (*June* 15, 1952).

The fast neutron spectrum is determined from the pulse-height distribution of recoil protons in a stilbene crystal, the pulse-height being measured by a multi-channel kicksorter in which only recoil protons carrying away more than 99% of the primary energy are effective, i.e. only head-on collisions are taken into account. This is accomplished by the use of a coincidence circuit operated only when scattered neutrons with energies of less than 30 keV (using a time-of-flight method) fall on a second crystal [NaI(Tl)] so placed that the scattering angle is very near 90°. J. THEWLIS

539.185.08

7582. Thermal neutron flux measurements in graphite using gold and indium foils. E. D. Klema and R. H. Ritchie. Letter in *Phys. Rev.*, **87**, 167 (*July* 1, 1952).

Corrections for attenuation and depression of the flux by the foils were investigated experimentally. Foils of various thicknesses were exposed and their saturated γ-ray activities were recorded. J. J. WILKINS

539.185.08

7583. A rotating-shutter time-of-flight spectrometer for the slow-neutron resonance region. W. Selove. *Rev. Sci. Instrum.*, **23**, 350–6 (*July*, 1952).

A high-speed rotating-shutter spectrometer has been built for making slow-neutron measurements in the resonance region, using a neutron "pile" as a source. One of the principal advantages of the new apparatus is that comparatively small samples are required—typically less than one gram. The design and operation of the apparatus are described. A.

539.185.08 : 771.3

7584. The measurement of neutron densities by the autoradiography of detectors. A. Ertaud and P. Zaleski. *C.R. Acad. Sci.* [*Paris*] **234**, 1969–71 (*May* 12, 1952) *In French.*

The neutron-induced activity in very thin metal foils can be measured by placing the foil in intimate contact with a photographic film. Provided one operates in the linear response region of the photographic film, the photographic density obtained is proportional to the neutron flux at the point of irradiation of the foil. A. C. COATES

539.185.7

7585. Total cross sections for 14-MeV neutrons. H. L. Poss, E. O. Salant, G. A. Snow and L. C. L. Yuan. *Phys. Rev.*, **87**, 11–20 (*July* 1, 1952).

With deuterons from the electrostatic generator of the Department of Terrestrial Magnetism incident on a tritium–zirconium target, and with the neutrons detected by a terphenylxylene scintillator and photomultiplier, total cross-sections of C, H, D, O and N for $14\cdot10 \pm 0\cdot05$ MeV neutrons were measured. The effective neutron energy was evaluated from the kinematics of the $T(d, n)He^4$ reaction, the dependence of the reaction's cross-section on energy and angle, and the multiple scattering of the deuterons and their rate of energy loss in the target. A least squares analysis of the transmissions of six thicknesses each of carbon and polyethylene (40 to 85% transmissions) yielded, for total cross-sections σ in barns: $\sigma_C = 1\cdot279 \pm 0\cdot004$ and $\sigma_H = 0\cdot689 \pm 0\cdot005$. Transmissions of light and heavy water gave $\sigma_D = 0\cdot803 \pm 0\cdot014$ and $\sigma_O = 1\cdot64 \pm 0\cdot04$. Transmission of melamine gave $\sigma_N = 1\cdot7 \pm 0\cdot1$. A.

539.185.7

7586. The evaluation of the rate of absorption, in a flat sample, of neutrons in process of being slowed down. B. Jacrot, F. Netter and F. Tyrode. *C.R. Acad. Sci.* [*Paris*] **234**, 2357–9 (*June* 9, 1952) *In French.*

The case is considered of a flat disk of absorber of non-negligible thickness placed in an isotropic flux of neutrons being slowed down. The number of neutrons captured in unit time is calculated for various laws of variation of capture cross-section as a function of energy. F. R. HOLT

STRUCTURE OF SOLIDS 539.2

539.21 : 532.7 : 536.7

Mixtures. (The theory of the equilibrium properties of some simple classes of mixtures, solutions and alloys.) *See Abstr.* 7245

539.215

7587. Theory of grain boundary diffusion. R. Smoluchowski. *Phys. Rev.*, **87**, 482–6 (*Aug.* 1, 1952).

The previously proposed [Abstr. 7303 (1951)] dependence of the structure of grain boundaries upon the angle of disorientation of the two grains is used as a basis of a quantitative consideration of diffusion along grain boundaries and in particular of the apparent activation energies. At small angles in the dislocation range the diffusion is controlled by volume diffusion mechanism. At high angles near 45° the model of a uniform grain boundary is applicable. In the intermediate range an array of rod-like areas of distorted lattice leads to low or even negative apparent activation energies. The theory is in good agreement with experiment. A.

539.217

7588. Grain boundary diffusion of zinc in copper. R. Flanagan and R. Smoluchowski. *J. Appl. Phys.*, **23**, 785–7 (*July*, 1952).

In continuation of a previous study of grain boundary diffusion of Ag in Cu the grain boundary diffusion of Zn along grain boundaries of columnar Cu has been investigated at various temperatures. The results confirm the influence of the angle between the grains on diffusion and indicate an angular dependence of the activation energy. The latter reaches very small or even negative values in a certain range of orientation in agreement with the proposed model. A.

539.217

7589. Self-diffusion in solid sodium. I. N. H. Nachtrieb, E. Catalano and J. A. Weil. *J. Chem. Phys.*, **20**, 1185–8 (*Aug.*, 1952).

Measurements are reported for the self-diffusion of solid Na over the temperature range, 0°–95°C. The data fit the empirical equation $D = 0{\cdot}242 \exp(-10\,450/RT)$ with an uncertainty of ± 300 cal mole^{-1} in the heat of activation. The entropy of activation calculated from the temperature coefficient of the elastic modulus is in agreement with the value based upon the vacancy mechanism. A.

539.217

7590. Self-diffusion in solid sodium. II. The effect of pressure. N. H. Nachtrieb, J. A. Weil, E. Catalano and A. W. Lawson. *J. Chem. Phys.*, **20**, 1189–93 (*Aug.*, 1952).

Hydrostatic pressure is found to decrease the rate of self-diffusion in Na. The free energy of activation is a linear function of the melting point, and the enthalpy of activation is proportional to the melting point. For Na and for all cubic metals (except Pb and W) for which diffusion data exist the enthalpy of activation is related to the latent heat of fusion by the equation $\Delta H = 16{\cdot}5\, L_m$. The change in D_0 for Na with pressure is expressible in terms of the compressibility and the activation entropy change. A.

539.217 : 539.43

7591. On some laws of diffusion and mechanic properties of metals. I. Ya. Dekhtyar. *Dokl. Aka Nauk SSSR*, **80**, 875–8 (*No.* 6, 1951) *In Russian.*

The energy of activation of creep $E = E_a^\circ +$ $(\sigma_1 v_a/2)$ coth $(\sigma_1 v_a/2RT)$, where E_a° is the activatio energy in the absence of effective internal stress (approximately equal to the activation energy of sel diffusion), and v_a is the volume per atom. Th expression, derived on the basis of the absolute ra of reaction theory, is analogous to the semi-empiric expression of Vitman *et al.*: $U = U_1 - U_2 \tanh a$ where $U = E$, $U_1 = E_a^\circ$, U_2 and a are constants, an σ is the externally applied stress. These formula permit the correlation of σ and σ_1 for various metal A slightly modified reasoning is used to explain th effect of a third element on the diffusion of a binar alloy. A. Gelbtuch

539.217

7592. On the calculation of diffusion coefficient from sorption data. Jenn Lin Hwang. *J. Chem Phys.*, **20**, 1320–3 (*Aug.*, 1952).

The general equation of diffusion in which th diffusion coefficient $D(c)$ is given by $D_0(1 + \alpha c + \beta c^2 + \ldots)$, where $\alpha, \beta \ldots$ are small, can be solve by the method of successive approximation the solution has the form $c(\xi) = c_0[1 - \Phi(\xi)] + c_0^2\alpha\psi(\xi) + c_0^3[\alpha^2\chi_1(\xi) + \beta\chi_2(\xi)] + \ldots$, where $\Phi(\xi)$ is the error function and $\psi(\xi), \chi_1(\xi) \ldots$ may b computed by numerical integrations. On the othe hand, one knows from the sorption experiments th quantities defined by $Kc_0 = 2D_0^{\frac{1}{2}}\int_0^\infty c(\xi)d\xi$ as a functio of c_0. Thus, by the above solution one may obtai a set of linear equations, from which the constant $D_0, \alpha, \beta \ldots$ can be found with a reasonable amoun of labour. For practical purposes it would b necessary to tabulate the functions $\psi(\xi), \chi_1(\xi), \ldots$ because they are needed for all the problems of th kind.

539.23

7593. A mechanism for sputtering in the hig vacuum based upon the theory of neutron coolin F. Keywell. Letter in *Phys. Rev.*, **87**, 160–1 (*July* 1952).

The observed inefficiency of ions in releasi secondary sputtered particles is accounted for b assuming that the ion loses energy in the crystalli lattice by a similar mechanism to neutrons in moderator. In this process the ion will make on a few collisions in which the energy transfer will b large enough to cause sputtering. J. Hugh

539.234 : 537.533

Radiation from freshly evaporated layers of met and salts. *See Abstr.* 7334

539.

7594. An X-ray method for the quantitative dete mination of molecular orientation in non-crystallizi resins. B. V. Lukin. *Zh. Tekh. Fiz.*, **21**, 663–6 (*N* 6, 1951) *In Russian.*

The diffraction rings from amorphous rubbe natural and synthetic, filled to various degrees wi carbon, were photometered along their circu ferences. From the differences between meridio and equatorial intensities an index representing t

degree of orientation was calculated and correlated with extension, resistance to abrasion and degree of filling. A. L. MACKAY

539.26 : 537.531 : 535.42

7595. Latex particle size determination using diffraction peaks obtained with the point focusing X-ray monochromator. W. E. DANIELSON, L. SHENFIL AND J. W. M. DUMOND. *J. Appl. Phys.*, **23**, 860–5 (*Aug.*, 1952).

The suitability of the instrument [Abstr. 0000 (1952)] for this particular study is described and the experimental data obtained are tabulated, these data coming from experiments with three physically distinct samples of Dow latex. A critical interpretation of the data is attempted by considering separately several possible space arrangements which the latex spheres might assume when the water, which is initially the suspending fluid, is evaporated. Corrections for the finite size and shape of the "point" focus are described. The absence of a significant difference in the mean particle sizes of the three samples considered is established. The data from all three samples is combined to yield a mean particle diameter under an external pressure of one atmosphere of 2687·5 Å with a statistical standard deviation of 1·2 Å and a fixed (systematic) error estimated to be not more than ±7 Å. A.

539.27

7596. Electron diffraction study on the ordered alloy Au_3Cu. S. OGAWA AND D. WATANABE. *J. Phys. Soc. Japan*, **7**, 36–40 (*Jan.–Feb.*, 1952).

Thin films of Au_3Cu were prepared by the evaporation method, and an imperfect but sufficient order was formed in them after annealing at about 200°C for 100 ~ 200 hr. The films, whose transmission photographs showed clear superlattice rings, were heated step by step up to 400°C or 500°C, and the collapsing manner of order was observed by gradual transition of diffuse superlattice rings to broad and faint bands, which persisted even at far higher temperatures than the transition point. Results agreed well with those of Germer (1942) and others in Cu_3Au, and these electron diffraction studies supported the results obtained by the specific heat measurements on the behaviour of Cu_3Au, Au_3Cu and CuAu at higher temperatures. A.

539.27

7597. The reliability of internal standards for calibrating electron microscopes. J. H. L. WATSON AND W. L. GRUBE. *J. Appl. Phys.*, **23**, 793–8 (*July*, 1952).

Conclusions important to the practice of electron microscopy are drawn from experiments. Particles of Dow Latex 580G are unstable under electron beams and best micrographed at low intensity. Two different effects of radiation are noted. At low intensity the mean diameter in the present work was 2890 Å, the standard deviation of the spherical particles was 60 Å. 580G is improved as an internal standard if recalibrated by some other suitable standard (not the reverse) each time before use. Fresh replicas of diffraction gratings are still the most practical standards, reproducing gratings to 2%. By an independent optical method (spectroscopy) one can measure the grating space of a replica when it is on an ½ in, 200-mesh specimen screen under exact calibration conditions for electron microscopes. Specific replicas, and from them specific preparations of 580G are checked easily and accurately by the spectroscopic method. Replica age or other factors which may affect accurate reproduction of an original grating are then no longer important in calibration. A reliable method of calibration using 580G is suggested. A.

539.27

7598. Electron microscopy of synthetic latices. S. H. MARON, C. MOORE AND A. S. POWELL. *J. Appl. Phys.*, **23**, 900–5 (*Aug.*, 1952).

A study has been made by electron microscopy of the size and size distribution of 22 synthetic latices. Included are GR-S latices Types II, III and V, polystyrene latices, and several latices of special character. Details are given on sample preparation, measurement, application of corrections, calculation of number, volume to surface and molecular weight average diameters, as well as the number and weight average distributions. The weight average particle size range covered was 730 to 3920 Å. The smallest sizes were shown by Type II latices, followed in order by Type III, polystyrene, Type V, and some of the special latices. The latices were all nonhomogeneous in size and showed size distributions both on a number and weight basis which in some instances contained single and in some cases double maxima. A.

ELASTICITY . STRENGTH . RHEOLOGY
539.3/.8

539.32

7599. A study of some factors influencing the Young's modulus of solid solutions. A. D. N. SMITH. *J. Inst. Met.*, **80**, 477–82 (*May*, 1952).

The values of Young's modulus for a series of binary solid solutions of copper with zinc, gallium, germanium, silicon and arsenic, and of silver with cadmium, indium and tin, have been measured dynamically at room temperature. In agreement with earlier work, it was found that, in any one system, the modulus decreases approximately linearly with the atomic percentage of the solute, although the rate of decrease differs for each system. This rate of decrease depends not only on the difference in atomic radii of the solute and solvent, as suggested by Zener [Abstr. 5025 (1949)], but also on the difference in valency between the two constituents. It appears that this latter effect may be proportional either to the square of the valency of the solute or to the electron concentration of the solution, the experimental evidence slightly favouring the former. A close relation is found to exist between the rates of decrease of the modulus and of the solidus temperature for any given solution of copper or of silver. A.

539.32

7600. Anelasticity of zinc. S. TAKAHASHI. *J. Appl. Phys.*, **23**, 866–8 (*Aug.*, 1952).

Anelastic properties of Zn single crystal of high

purity (99·996%) have been studied, using bars vibrating transversely at audio frequencies in free-free modes. Internal friction, effective elasticity and shape of resonance curve were determined against the strain amplitude. When the driving force exceeds a critical value, the internal friction increases, its maximum-amplitude-frequency decreases and its resonance curve becomes asymmetrical. Furthermore, under this condition a discontinuous phenomenon, which is supposed to be closely correlated with slips occurring in the crystal, has been found. This discontinuous phenomenon was recorded under different stresses. A.

539.32 : 534.22/.23

Longitudinal and transverse ultrasonic waves in a synthetic review. *See Abstr.* 7118.

539.373

7601. On the formation of slip bands in single crystals of sodium nitrate. S. Ya Zalivadnyĭ. *Dokl. Akad. Nauk SSSR*, **81**, 1063–4 (*No.* 6, 1951) *In Russian.*

Single crystals of sodium nitrate, subjected to axial compressive loads are deformed by twinning [Abstr. 2319 (1947)] at 195°–270°c, by twinning or slip at 270°–290°c, and by slip only at 290°–308°c. In cleavage rhombohedrons slip bands are first formed along plane [111] in the direction [011] and, on further deformation, along planes {[100]} in the direction {[101]}. In crystals having the shape of rectangular columns bounded on four sides by cleavage planes, slip occurs first along planes {[100]} in the directions {[101]}, and continues along plane (111) in the direction [011]. A. GELBTUCH

539.373

7602. Failure and fracture of metals as nucleation processes. T. Yokobori. *J. Phys. Soc. Japan*, **7**, 44–7 (*Jan.–Feb.*, 1952).

The discontinuous phenomena in plasticity of metals, such as the yielding, the state of ultimate strength and the brittle fracture, were regarded as a kind of Markoff process, and studied from the standpoint of nucleation theory. The fundamental features of these types of failures, namely, (1) the relation between strength and deformation velocity or stress velocity, (2) the temperature dependence of strength, (3) the size effect, (4) the transition temperature from ductile to brittle failure, (5) the fluctuation characteristics of strength were uniformly interpreted. Theoretical criterions of failure and fracture of polycrystalline metals were also introduced. A.

539.373

7603. Creep fracture of copper as nucleation process. T. Yokobori. *J. Phys. Soc. Japan*, **7**, 48–51 (*Jan.–Feb.*, 1952).

Creep fracture of Cu wire was regarded as a kind of Markoff process, and studied from the standpoint of nucleation theory. The theory indicates the power relation between stress and time for fracture which is in good accord with experiments. The dependence of time for fracture on the stress, the temperature and the length of specimen was experimentally obtained. The fluctuation characteristics accompanying these phenomena were also studied. These experiments were interpreted from the theory. A.

539.373

7604. Electron-microscopic studies of slip in aluminium during creep. J. Trotter. *J. Inst. Met.*, **80**, 521–3 (*May*, 1952).

The slow deformation of a specimen of 99·98% aluminium at 200°c has been studied by means of the electron microscope, using the plastic-replica process. It is shown that the slip zones do not consist of bundles of long parallel slip lamellae of the type found by Heidenreich and Shockley [Abstr. 1096 (1948)] in room-temperature deformation, but of intimate segments of primary and cross-slip. A direct consequence of this is that the direction of a slip zone does not, under the conditions of the present experiment, coincide with the trace of the slip plane and, indeed, it may be far removed from it. A.

539.373 : 548.0

7605. Boundary slip in bicrystals of tin. K. E. Puttick and R. King. *J. Inst. Met.*, **80**, 537–44 (*June*, 1952).

Specimens of tin consisting of two crystals meeting in a straight boundary were stressed in shear to cause relative movement of the crystals at the boundary. The relation between relative movement and time under steady stress was examined at a number of stresses and temperatures, for a standard type of specimen in which the *c* axes of the crystals were at right angles to one another and at 45° to the boundary. Over the range of stresses (500–2100 g/cm²) and temperatures (180°–225°c) employed, the initial rate of relative movement obeyed the relation: rate of movement $= A\sigma \exp(-19\,200/RT)$, where σ is the shear stress across the boundary. The behaviour of the crystal boundary was therefore analogous to that of a viscous liquid. The physical character of the boundary was found to depend on the nature of the impurities present in the tin. Boundaries in cast specimens of two samples of tin of similar total impurity content, but differing in the relative amounts of impurities, were of different appearance. Straining and annealing produced similar boundaries in the two types of tin. A.

539.374 : 548.0

7606. On the discontinuous elongation of aluminium crystals. IV. T. Kawada. *J. Phys. Soc. Japan*, **7**, 240–4 (*May–June*, 1952).

For Pt III, see Abstr. 8280 (1950). In Pt I discontinuous elongations of magnitude of a few micron were observed for coarse grain polycrystal specimens of commercial Al. In this paper the behaviour of slip lines near the grain boundary was observed and it was found that when the slip lines continued across the grain boundary the discontinuous elongation was not observed, while the jumps occurred when the slip lines terminated at the grain boundaries. From these results the cause of the discontinuous elongation was discussed. A.

539.385

7607. Cross-elasticity. M. Reiner. Letter in *Bull. Res. Coun. Israel*, **1**, 126 (*March*, 1951).

Preliminary communication. The lengthening of steel wire on finite torsion quoted as an example.

J. E. CAFFYN

539.4.016.2

7608. Measurement of the internal energy in copper introduced by cold work. B. WELBER. *J. Appl. Phys.*, **23**, 876–80 (*Aug.*, 1952).

A determination was made of the ratio of the stored energy to the energy expended in cold-working copper by twisting. Ratios of about 0·03 were found in three cylindrical samples which were cold worked to the extent of 8 to 12 cal/g. A.

539.4.019.1

7609. Note on the strain aging of iron single crystals. A. N. HOLDEN AND F. W. KUNZ. Letter in *J. Appl. Phys.*, **23**, 799 (*July*, 1952).

Annealed crystals with 0·005% C show a marked increase in the upper yield point after ageing at room temperature for 1 hr under a stress of only ~2/3 the yield stress. Deformed crystals, aged while still subject to a high stress, show subsequently a higher upper yield point than if aged with the stress relaxed.

A. D. LE CLAIRE

539.42

7610. Some tests for hypotheses concerning tensile strength of cloth. J. HEMELRIJK. *Appl. Sci. Res. A*, **3**, 211–24 (*No.* 3, 1952).

This strength may be tested by stretching a strip until it breaks and measuring the maximum tension which is attained during this process. The experiment may be performed in such a way that the time, necessary to attain the breaking point, has a predetermined length. This is called the testing time and it appears that it influences the tensile strength. The present paper gives a number of statistical tests which enable certain properties of the relation between the two quantities mentioned to be investigated. The use of the tests is demonstrated by a numerical example. A.

539.42 : 535.55

7611. A photoelastic study of rupture under pure flexure. F. ZANDMAN. *C.R. Acad. Sci.* [*Paris*] **234**, 2337–9 (*June* 9, 1952) *In French.*

The conclusions drawn from previous work [Abstr. 8276 (1951)] are confirmed by studying the progress of the rupture of a rod of methyl methacrylate by means of high-speed photography of the fringes. The sequence of phenomena observed from the moment of impact are briefly stated. A. J. KENNEDY

539.42 : 666.1/.2

7612. Experimental determination of the speed of propagation of cracks in glass as a function of the stress. N. LUNDBORG AND C. H. JOHANSSON. *Ark. Fys.*, **4**, 555–8 (*Paper* 39, 1952).

Contrary to the results of Schardin and Struth (1938), Smekal (1950) and Edgerton and Barstow (1941), the speed of propagation of cracks in glass was found to depend on the magnitude of the stress σ, being equal to 0 at $\sigma = 0{\cdot}8 - 0{\cdot}9$ Kp/mm² and approaching the previously determined "constant" of 1500 m/sec. for $\sigma > 3$ Kp/mm². A. GELBTUCH

539.42 : 539.27 : 539.211

7613. Electron microscopy of the fracture surface of glass. N. TERAO AND S. OKADA. *J. Phys. Soc. Japan*, **7**, 427–9 (*July–Aug.*, 1952) *In French.*

Small rounded bodies were observed on the smooth parts of the surface of fracture. These are perhaps lens-shaped fractures produced parallel to the surface of the principal fractures in sudden rupture of glass. A.

539.434

7614. Creep processes in coarse-grained aluminium. D. MCLEAN. *J. Inst. Met.*, **80**, 507–19 (*May*, 1952).

A specimen of super-pure aluminium was extended under a constant load of ½ ton/in² at 200°C to fracture, which occurred at 65% extension in 850 hr. Observations were made of slip-band and grain-boundary movements, on a previously polished surface. The movements were measured, mainly by means of an interference microscope, and their respective contributions to the creep extension calculated. They accounted for only about one-half of the total extension, and it was necessary therefore to seek the cause of the "missing" creep. It was believed that fine slip, difficult to detect, or viscous flow might be responsible. Evidence was found that fine slip occurred throughout the extension, and polygonization in the second stage, the latter involving viscous flow by the diffusion of dislocations; there was also some evidence that the known breakdown of the original crystals into sub-crystals operated in this case by the specific mechanism of polygonization. It was possible to measure the orientation tilts between adjacent sub-crystals, and the creep extension attributable to fine slip was thus calculated to be of the same order of magnitude as the missing creep. It is concluded that, under the conditions of the experiment, creep occurred by coarse slip, fine slip, and grain-boundary displacement. A.

539.434

7615. The creep of metals under interrupted stressing. A. J. KENNEDY. *Proc. Roy. Soc. A*, **213**, 492–506 (*July* 22, 1952).

The creep behaviour of polycrystalline lead subjected to interrupted stress, or "stress pulses," has been examined with an apparatus which enables the creep curve to be recorded as a magnified photographic trace. When the metal is reloaded after an interruption, a new creep transient is exhibited which can be adequately expressed by assuming a fraction n of the material to have recovered its original Andrade β-flow properties, whilst the remaining fraction $(1 - n)$ continues to deform as if unloading had not occurred. It is shown that this analysis is valid whether the material exhibits a finite Andrade κ-flow or not. The variation of n with the time of creep (τ) previous to the interruption, for a constant recovery time (R), and the variation of n with R for a constant τ, are each investigated. The full component analysis is worked out for four stages, but the exact calculation rapidly becomes too unwieldy, and approximations are developed to deal with the case of regular repetitive stress pulses. It is shown that the creep under these conditions may be very closely formulated from measurements of uninterrupted creep coupled with knowledge of the value of n for the first interruption. The problem of a constant stress cycle, i.e. $\tau + R =$ constant $(=\lambda)$, is specially treated, and the significant effect of the τ/λ ratio is demonstrated; it is, for example, possible, with a given duration of test, for interrupted stress to bring about a greater creep strain than uninterrupted creep at the same stress.

Because of the character of the β-against-stress curves, nearly square β-pulses can occur in structures subjected to sinusoidal stress cycles, and the treatment has, therefore, a very wide application. A.

539.434 : 539.27

7616. X-ray diffraction studies in relation to creep. G. B. GREENOUGH, C. M. BATEMAN AND E. M. SMITH. *J. Inst. Met.*, **80**, 545–50 (*June*, 1952).

To investigate a hypothesis regarding the mechanism of creep put forward by Greenough and Smith [Abstr. 9050 (1950)], two aluminium-silver alloys, one a solid solution and the other containing a precipitate, were examined. While the former behaved in the same manner as pure aluminium and showed marked cell development during creep, the latter exhibited no traces of such cells. Experiments were also carried out on the recovery of specimens quickly pulled at either 20° or 300°C. It was confirmed that whereas annealing at 300°C in the absence of stress caused little recovery, cell development occurred if the specimens were allowed to creep at this temperature. The cell development did not become apparent until the creep strain was appreciable; the influence of the strain rate appeared to be small. It is considered that the ideas based on dislocation theory and polygonization provide a simple explanation of the experimental results and are more satisfactory than an explanation in terms of boundary micro-movements. A.

539.501

7617. Time-temperature dependence of linear viscoelastic behavior. F. SCHWARZL AND A. J. STAVERMAN. *J. Appl. Phys.*, **23**, 838–43 (*Aug.*, 1952).

The question is treated whether change of temperature is completely equivalent to a shift of the logarithmic time scale or not. If it is, the material is termed "thermo-rheologically simple" (class *A*). It is shown that, by plotting the results of a similar rheological experiment (for instance, a creep experiment) performed at different temperatures and comparing the curves obtained, one can decide whether the materials considered belong to class *A* or not, by seeing whether the curves can be made to fit by shifting them along the axis of logarithmic time. Once the material has been decided to behave as thermo-rheologically simple, one can plot the function describing the time-shift as function of the temperature. Some examples of thermo-rheologically simple materials are quoted from the literature. The micro-rheological conditions for thermo-rheologically simple behaviour are discussed. It turns out that this behaviour implies that in similar deformations at different temperatures always the same sequence of molecular events follows, whereas in materials not belonging to class *A*, not only the speed, but also the sequence of molecular processes changes when the temperature of the experiment changes. This implies, that materials of class *A* cannot from a heat treatment assume a special structure which could not be obtained by one temperature, whereas for materials of class *B* a heat treatment can indeed result in a special structure. It is reasonable to expect that thermo-rheologically simple materials will be found only among polymers containing no crystallites and no pronounced polar groups. A.

539.62

7618. On the energy equation for fluid-film lubrication. A. CHARNES, F. OSTERLE AND E. SAIBEL. *Proc. Roy. Soc. A*, **214**, 133–6 (*Aug.* 7, 1952).

The energy equation for fluid-film lubrication is developed in such a way as to resolve the discrepancy that now exists in the literature because of the fact that two obviously different energy equations have been used. A qualitative estimate of the error introduced by the use of the incorrect equation is given. A.

PHYSICAL CHEMISTRY 541

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.11 : 533.16

Measurements of the physical properties of active nitrogen. *See Abstr.* 7087

541.123.2

7619. Two-phase equilibrium in binary and ternary systems. IX. Derivation of the general equation defining a small change at equilibrium. R. F. STRICKLAND-CONSTABLE. *Proc. Roy. Soc. A*, **214**, 36–43 (*Aug.* 7, 1952).

For Pt VIII, see Abstr. 9758 (1951). Two well-known equations define a small change in such a system for two special cases, namely, the transfer of the first and of the last drops from one phase to the other. The equation that is now derived is for the general case of transfer of a drop for any relative sizes of the phases. A general method of calculating partial differential relations in such a system is also described. A.

541.123.

7620. Exchange of iodine between sodium iodide and para-iodonitrobenzene. Effect of the solvent. S. MA AND B. GIRAUDEL. *C.R. Acad. Sci.* [*Paris*] **234** 2280–1 (*June* 4, 1952) *In French.*

It has been found that the reaction of iodin exchange is of the 2nd order when the solvent i acetonitrile, and of the 1st order when the solvent i 2-octanol. Radio-iodine (isotope 131, period 8 days was used as tracer element. F. LACHMA

541.12

7621. A parabolic law for metal oxidation which i not controlled by diffusion. W. J. MOORE. Letter i *Phil. Mag.*, **43**, 688–9 (*June*, 1952).

Suggests a mechanism not based on diffusion t explain the parabolic law in the oxidation of Zn, T Zr and Al, for which the activation energies hav low, and the activation entropies have high, value By assuming that O atoms are adsorbed by th interstitial Zn atoms, the former becoming O^- an

the latter Zn^+, and that the former accept then a second electron, a parabolic rate constant is obtained.
F. LACHMAN

541.127

7622. Constant pressure apparatus for studying reaction rates. W. DAVIS, JR AND F. D. ROSEN. *Rev. Sci. Instrum.*, **23**, 332–3 (*July*, 1952).

An automatic constant pressure system has been designed and constructed on the basis of fluid displacement in a sylphon bellows system. Booth–Cromer pressure transmitters, operated in conjunction with appropriate self-balancing relays, have been used to maintain constancy of pressure. The apparatus has been tested at 25 and 60°C with air or fluorine as the confined gas at total pressures of $\frac{1}{3}$ to $\frac{1}{2}$ atmosphere and for periods as long as 30 days. Reaction or evacuation rates of 1 to 16 000 cc atmos per day gave pressures that have been found to remain constant within about 1%. A.

541.127

7623. Chemical reactions near equilibrium. W. R. GILKERSON, M. M. JONES AND G. A. GALLUP. Letter in *J. Chem. Phys.*, **20**, 1182–3 (*July*, 1952).

It is shown that, according to the theory of absolute reaction rates, the rate near equilibrium is proportional to the free energy difference between reactants and products. H. H. GREENWOOD

541.127 : 537.226.08

7624. Dielectric constant meter for kinetic studies. R. C. AXTMANN. *Analyt. Chem.*, **24**, 783–5 (*May*, 1952).

A recording heterodyne beat assembly was constructed for determining reaction velocity constants by following small increments in the dielectric constant of the reaction medium. In one study, a second-order velocity constant was determined ten times with an average deviation from the mean of only 0·12%. The method can be further refined for even greater accuracy. A.

ELECTROCHEMISTRY 541.13

541.132

7625. The measurement of Donnan potentials with cellulose and aqueous solutions. S. M. NEALE AND P. T. STANDRING. *Proc. Roy. Soc. A*, **213**, 530–45 (*July* 22, 1952).

A method is described whereby the single potential difference between the membrane and a solution of KCl in which it is immersed may be determined. The experimental results are in agreement with the view that the membrane may be regarded as an aqueous region of uniform potential, and that this potential is dependent on a Donnan distribution of the mobile ions. The degree of dissociation of the non-diffusible ionogenic groups depends on the concentration of neutral electrolyte solution in contact with the membrane, since, on account of the Donnan effect, the pH of the solution imbibed by the membrane differs from that of its external environment. Values for the dissociation constant of the carboxylic acid groups in Cellophane have been obtained from the present results. When hydrochloric acid is the electrolyte, and in salt solutions of low pH, the dissociation of the carboxylic acid groups is almost entirely repressed, and the Donnan potential vanishes. The results obtained with materials of artificially enhanced carboxyl content are also in agreement with expectation, and indicate that the Donnan potential is due solely to the presence of carboxylic acid groups. The variation of the potential with the water imbibition of the cellulose lends further support to the concept of the swollen membrane as an equipotential region. A.

541.135

7626. Quantitative experiments on electro-osmosis, and their contribution to the study of ionic hydration. S. SERNESSE AND L.-H. COLLET. *C.R. Acad. Sci.* [*Paris*] **234**, 2281–3 (*June* 4, 1952) *In French.*

Apparatus is described for the study of electro-osmosis in which the membrane cannot participate in the electrolysis, and experimental results are given for aqueous solutions of HCl, NaCl, KCl, NaBr, KBr, NaI and KI at dilutions of 10^{-1}M, 10^{-2}M, 10^{-3}M and 10^{-4}M, at constant current (from 0·1 to 50 mA) and at voltages not exceeding 100 V for the more dilute solutions. The data are discussed with respect to ionic hydration. H. H. HODGSON

541.136

7627. Reversible cell whose electrolyte is a crystal deposited in a thin lamina by evaporation. A. SATOR. *C.R. Acad. Sci.* [*Paris*] **234**, 2283–5 (*June* 4, 1952) *In French.*

Details are given of a reversible cell whose positive pole is a silver electrode coated with silver chloride, and whose negative pole is lead, the electrolyte being a crystal of lead chloride of thickness $\sim 10^{-4}$ cm deposited on silver coated with silver chloride by evaporation of lead chloride *in vacuo*. The cell is Ag|Pb|$PbCl_2$|AgCl|Ag+, and its mode of operation:

$$PbCl_2 + 2Ag \underset{\text{discharge}}{\overset{\text{charge}}{\rightleftharpoons}} Pb + 2AgCl.$$ H. H. HODGSON

541.138.3

7628. Nature of the primary radicals produced in the reduction of aromatic nitro-compounds. L. HOLLECK. *Z. Naturforsch.*, **7a**, 282–4 (*March–April*, 1952) *In German.*

From the deformed polarographic potential curves which are obtained when sufficient of a surface active substance is added to a solution of an aromatic nitro-compound, it is possible to draw conclusions about the nature of the radicals produced as primary products in the cathodic reduction of nitro-compounds. These radicals are weak acids, and in the case of *p*-nitraniline the dissociation constant is estimated to be about 10^{-7}. A. J. MEE

PHOTOCHEMISTRY . RADIATION CHEMISTRY 541.14/.15

541.14

7629. A new form of the Draper–Bunsen actinometer. E. CREMER AND H. MARGREITER. *Z. phys. Chem.*, **199**, 90–9 (*Jan.*, 1952) *In German.*

The Draper–Bunsen actinometer is greatly improved

by admixture of as much O as Cl with the H. In this way the quantum efficiency is reproducible. It is shown theoretically and experimentally that the chain reaction in this case consists of 15 to 18 events.

A. J. TAYLOR

541.14

7630. Photochemistry of ferrous ions in aqueous solution. T. RIGG AND J. WEISS. *J. Chem. Phys.*, **20**, 1194–9 (*Aug.*, 1952).

The photochemistry of ferrous ions in aqueous solutions has been investigated, and it has been confirmed that irradiation in the quartz ultraviolet, in the absence of O, leads to the formation of ferric salt and molecular H. It has been concluded further that the primary absorption of a light quantum results in the formation of excited ions $(Fe^{2+}.H_2O)^*$, a considerable proportion of which undergo processes of deactivation, while the remaining (about one-tenth) dissociate according to $(Fe^{2+}.H_2O)^* \rightarrow Fe^{3+} + OH^- + H$, leading to the formation of H atoms. The latter can undergo back reactions of the type $Fe^{3+} + H \rightarrow Fe^{2+} + H^+$. Investigation of the pH dependence of the quantum yield has led to the assumption that H atoms can also react according to $H + H^+_{(hydr)} \rightleftharpoons H_2^+{}_{(hydr)}$, leading to the formation of hydrated H molecular ions which intervene in this process according to the reaction $Fe^{2+} + H_2^+ \rightarrow Fe^{3+} + H_2$. Other experimental evidence and some theoretical considerations which have led to the assumption of $H_2^+{}_{(hydr)}$ in aqueous solution are referred to. A.

541.14 : 542.944

7631. On the bromination of neopentane. S. W. BENSON AND H. GRAFF. Letter in *J. Chem. Phys.*, **20**, 1182 (*July*, 1952).

Suggests a reaction mechanism for which the activation energy and steric factor are more consistent with those for comparable reactions than in the mechanism proposed earlier [Abstr. 7349 (1951)].

H. H. GREENWOOD

541.14 : 551.510.4

7632. The photo-chemistry of some minor constituents of the earth's atmosphere (CO_2, CO, CH_4, N_2O). D. R. BATES AND A. E. WITHERSPOON. *Mon. Not. Roy. Astron. Soc.*, **112**, 101–24 (*No.* 1, 1952).

The rate of photo-dissociation of CO_2 is appreciable only in the region above about 100 km. If local equilibrium prevails the carbon would occur mainly as the monoxide in this region, and as the dioxide below. However, oxidation may proceed so slowly that the life of a CO molecule is long compared with the characteristic time associated with atmospheric mixing effects. In this case the CO resulting from photo-dissociation would not be confined to above the 100 km level, but would extend much lower; its total abundance could scarcely be great enough to produce the observed absorption lines. It is estimated that the various forms of combustion taking place on the Earth would provide the CO content of the atmosphere within perhaps four years or even less. Dissociation of CH_4 in the upper atmosphere is brought about mainly by collision processes. These prevent the existence of appreciable CH_4 above the 100 km level and probably keep the concentration low even down to 70 km. The yield to date from oil wells and coal mines appears to be less than the amount of the gas now in the atmosphere. Seepage from fuel beds, and the anaerobic decay of vegetable matter, are the only obvious naturally occurring sources of significance. As far as can be judged at least ten years (and probably much longer) is required for the production of the atmospheric abundance. Information on the necessary rate of formation of N_2O is obtained by calculating the photo-dissociation rate. One hypothesis is that soil micro-organisms produce the gas, but it appears that the yield would only be sufficient if N_2O were a major end-product of denitrification. Many of the homogeneous gas reactions suggested by earlier workers must be rejected, since there is an inadequate supply of the requisite parent particles. The only acceptable parent particles seem to be those arising directly or indirectly from the photo-dissociation of O_2 in the Herzberg continuum. Various reactions involving O, O_3 and N_2 are discussed. Though they are very slow they might nevertheless give rise to sufficient N_2O. A.

541.15

7633. Effect of ring on radiation chemistry of alkyl-substituted benzenes. M. BURTON, S. GORDON AND R. R. HENTZ. *J. Chim. Phys.*, **48**, 190–4 (*March–April*, 1951).

Photolysis of liquid alkyl benzenes at 2537Å produces gas volatile at −120°C with quantum yield of the order of 10^{-4}. Energy absorbed in the π-electron system of the benzene ring causes rupture preferentially of bonds β to the ring, with the weaker bonds being most affected. Radiolysis of the same compounds with 1·5-MeV electrons gives 100-eV yields (G values) of the order of 0·2. Calculated primary G values according to the rule of averages (allowing for radical absorption by benzene rings following methods elsewhere described) are much higher than those estimated directly from the data here given. The discrepancy is attributed to a real protective effect, of the so-called "sponge" type, by the benzene nucleus. In this type of protection energy originally liberated in the alkyl group by the radiation, either as excitation or ionization, is transferred to the ring and dissipated. Transfer of energy from the ring to the side group, with an ensuant chemical effect, also occurs but such destructive effects play a minor role in comparison with protection. A.

541.15

7634. Effects of X-rays on aqueous solutions of indole. C. B. ALLSOPP AND J. WILSON. *J. Chim. Phys.*, **48**, 195–7 (*March–April*, 1951).

Dilute aqueous solutions of indole are very sensitive to X- and γ-rays; but when the indole is estimated with Ehrlich's reagent, which measures pyrrole, a state of eqilibrium appears to be reached after doses of only a few r. Possible mechanisms are discussed.

C. B. ALLSOPP

541.15

7635. Energy absorption by externally irradiated liquids. II. S. L. WHITCHER. *Nucleonics*, **12**, 54–8 (*May*, 1952).

See also Abstr. 6853 (1952). Methods of converting ion-chamber measurements into values for the energy absorbed in liquids from X- or γ-ray beams are detailed. The conditions governing the variation of the ratio of absorption coefficients in air and various

liquids with photon energy, is examined. Expressions are derived for energy absorption in liquids in cylindrical and spherical cells. Requirements of chemical dosimeters and the suitability of certain systems are discussed. L. R. SHEPHERD

541.15

7636. The effect of oxygen on a radioreduction reaction. N. TODD AND S. L. WHITCHER. Letter in *J. Chem. Phys.*, **20**, 1172–3 (*July*, 1952).

0·0005N solutions of KIO_3 in purified water were irradiated with 250 kVP X-rays at various pH values with and without dissolved air. At pH 1, iodate was reduced, iodine and H_2O_2 being formed. In air-saturated solutions, but not in absence of air, a post-irradiation reaction immediately regenerated iodate. In neutral and alkaline solutions there was no iodine formed, but more iodate was reduced in absence of air. C. B. ALLSOPP

541.15 : 539.185.9

7637. A study of the action of neutrons on organic halides. C. H. COLLIE AND P. F. D. SHAW. *J. Chim. Phys.*, **48**, 198–201 (*March–April*, 1951).

Some of the factors affecting the efficiency of extraction of radio-halogens from neutron-irradiated organic halides are considered. In particular the role played by free radicals and unsaturated molecules produced by the recoiling halogen atoms is discussed. A.

541.15 : 577.1

7638. Some aspects of the biochemical effects of ionizing radiations. W. M. DALE. *J. Chim. Phys.*, **48**, 245–8 (*May–June*, 1951).

Constancy of ionic yield over a wide range of concentrations of irradiated solute, a characteristic of the indirect action of ionizing radiations, is not observed in the case of deamination of amino acids, where a continuous rise in ionic yield with concentration is found. Possible explanations are put forward. The yield of H_2S from irradiated cysteine hydrochloride is shown to be dependent on O_2 and on H_2O_2 concentration in the solution, and also on pH value. Curves are given for these effects. D. V. MABBS

DISPERSIONS . COLLOIDS . ADSORPTION
541.18

541.18.05

7639. The spontaneous emulsification of mixtures of oleic acid and paraffin oil in alkaline solutions. W. W. MANSFIELD. *Aust. J. Sci. Res. A*, **5**, 331–8 (*June*, 1952).

Interfacial tension values occurring during the transfer of oleic acid from paraffin oil to aqueous alkali have been determined by the sessile-drop method. It is postulated that the ease of emulsification observed with these systems arises from the nature of the changes in interfacial tension associated with the transfer. A.

541.182.33 : 536.25

7640. Thermal force on an aerosol particle in a temperature gradient. R. L. SAXTON AND W. E. RANZ. *J. Appl. Phys.*, **23**, 917–23 (*Aug.*, 1952).

Data on the thermal forces acting on aerosol particles in a temperature gradient are relatively few. Measurements are reported here on droplets of paraffin oil and castor oil suspended in air, showing the effect of temperature gradient, particle size and particle material. The thermal force is directly proportional to the temperature gradient prevailing in the gas and to the particle diameter. It is an inverse function of the thermal conductivity of the aerosol material. The agreement between the experimental data and the theory of P. S. Epstein [*Z. Phys.*, **54**, 537 (1929)] is satisfactory, a fortunate result in view of the approximations to the actual physical situation made in the derivation of the theoretical equation. The velocity of migration of aerosol particles in a temperature gradient can be estimated from Epstein's formula. A.

541.182.5.025 : 535.434

7641. Light scattering by some thixotropic gels. M. PRASAD, K. E. SUBRAMANIAN, R. L. DESAI AND C. R. KANEKAR. *J. Coll. Sci.*, **7**, 178–85 (*April*, 1952).

The measurements of depolarization factors and intensity of transversely scattered light have been made during the thixotropic gelation of aluminium molybdate and thorium molybdate gels. It has been observed that mechanical shaking of a thixotropic gel does not affect the size and the shape of the particles. The low values of ρv indicate that the particles in the gels are isotropic. A.

541.183

7642. Gas adsorption on crystal lattices. Validity of the isotherm of Peierls, Wang and Roberts for the case of an immovable film. P. BROVETTO. Letter in *Ric. Sci.*, **22**, 287–8 (*Feb.*, 1952) *In Italian.*

Calculations based on previous work of Peierls (1936) and others show that molecules are kept on that place on the surface of the adsorbent on which they have impinged, without being redistributed over the surface for assuming the equilibrium configuration suggested by Boltzmann's law. R. NEUMANN

541.183

7643. An application of the Gibbs' adsorption theory to films at oil–water interfaces. E. HUTCHINSON AND D. RANDALL. *J. Coll. Sci.*, **7**, 151–65 (*April*, 1952).

541.183

7644. Adsorption of myristic acid and palmitic acid on paraffin. L. GUASTALLA. *C.R. Acad. Sci.* [*Paris*] **234**, 2051–3 (*May* 19, 1952) *In French.*

Measurements are made of, (*a*) the interfacial pressures (p_i) defined as the difference between the adhesion tensions of solutions of the above acids to paraffin and that of pure solvent to paraffin, and (*b*) the surface pressure (p) of monomolecular films of the acids on water. These measurements are made at different values of molecular area and by integrating the Gibbs' equation a value is obtained of c/A for each value of p_i and p. c is the concentration of the layer of solution immediately underneath the surface and A is a constant of integration. Curves are drawn showing the relation between p_i and c/A and between p and c/A. The results are discussed in connection with the general problem of adsorption of long chain fatty acids on paraffin. J. IBALL

541.183

7645. On the hysteresis of adsorption on solid surfaces. R. G. WYLIE. *Aust. J. Sci. Res. A*, **5**, 288–302 (*June*, 1952).

Hysteresis phenomena associated with the adsorption of gases on solid surfaces are usually explained in terms of three-dimensional capillary effects or with more or less unspecific reference to phase transitions. It is shown that hysteresis effects are to be expected when two-dimensional phase transitions occur on solids. In this connection, the thermodynamic equation governing the equilibrium of small, incompressible two-dimensional phases is derived. Such phases can form on an imperfect solid surface in an irreversible manner and, as calculation shows, can contribute significantly to the hysteresis of adsorption. In some cases the phase change may be responsible for the whole effect. The diffuseness of first-order phase transitions may be due to the same mechanism. A.

541.183

7646. Capillary condensation in contact zones between nonporous particles of a powder. I. HIGUTI AND H. UTSUGI. Letter in *J. Chem. Phys.*, **20**, 1180–1 (*July*, 1952).

Adsorption isotherms of ethanol vapour on nonporous anatase powder composed of spherical particles 0·05 μ in diameter have been determined. Assuming capillary condensation (obeying the Kelvin equation) to occur in the interstices between the particles, the theoretical isotherm has been calculated for (1) closest packing, (2) planar close packing, (3) linear packing, of the particles. The experimental curve in the steep region near saturation agrees well with (2). S. J. GREGG

CHEMICAL STRUCTURE 541.2/.6

541.48

7647. Germanium subchloride. R. SCHWARZ AND E. BARONETZKY. Note in *Naturwissenschaften*, **39**, 256–7 (*No.* 11, 1952) *In German.*

A crystalline brown substance with composition $Ge_{1\cdot0}Cl_{0\cdot9}$ is obtained by reduction of $GeCl_4$. On heating to 210° in a high vacuum it gives yellow crystalline $GeCl_2$ and liquid $GeCl_4$. Amorphous GeCl is formed on heating $GeCl_2$ above 300°. An amorphous form of $GeCl_2$ is formed from Ge and $GeCl_4$. C. TURNER

541.57

7648. The hydrogen bond. I. Intra- and intermolecular hydrogen bonds in alcohols. L. P. KUHN. *J. Amer. Chem. Soc.*, **74**, 2492–9 (*May* 20, 1952).

The OH bands of a number of dihydroxy compounds have been measured in the 3 micron region. The presence of an intramolecular hydrogen bond was detected by the appearance of two OH bands. The separation of these bands, $\Delta\nu$, is a measure of the length of the hydrogen bond. The effects of substituents and structural changes upon $\Delta\nu$ is explained on the basis of changes in the geometry of the molecule. The values of $\Delta\nu$ for intra- and intermolecular hydrogen bonds are discussed. A.

541.57

7649. Conjugation energy. R. D. BROWN. *Aust. J. Sci. Res. A*, **5**, 339–45 (*June*, 1952).

The relationship between conjugation energies and self-atom-polarizabilities, previously [Abstr. 719 (1951)] derived from certain approximate theoretical relationships, is obtained in a more accurate form by an empirical least-squares calculation. An analogous relationship is also derived from calculating conjugation energies when the overlap integral is taken into account. A tabulation of all relevant polarizability data from the literature is presented, and a method of extending the data to larger molecules is described and exemplified. A possible alternative method of deriving conjugation energies is briefly discussed. A.

541.63 : 539.132

7650. Rotational isomerism and the vibrational spectrum of *sym*-dideuterodibromoethane. H. J. BERNSTEIN AND A. D. E. PULLIN AND B. S. RABINOVITCH AND N. R. LARSON. *J. Chem. Phys.*, **20**, 1227–31 (*Aug.*, 9152).

Trans-ethylene-d_2 was brominated by two methods, which involved different stereochemical paths, to give 95% *meso*-BrDHC–CHDBr as one product and a mixture of *meso*- and *racemic*-BrHDC–CHDBr as the other. Liquid phase Raman spectra and liquid and solid phase i.r. spectra of these materials have been obtained and a tentative assignment of the vibrational frequencies of BrDHC–CHDBr to the *trans* and *skew* configurations of the *meso* and *racemic* compounds has been made. A.

541.64 : 541.133.1

7651. Theory of ion exchange for polyelectrolytes undergoing electrolytic transference. F. T. WALL AND P. F. GRIEGER. *J. Chem. Phys.*, **20**, 1200–5 (*Aug.*, 1952).

It has been observed experimentally that polymeric ions generally have associated with them a large number of small ions of opposite charge. These smaller ions, which are considered bound to the polymeric ions, are capable of exchanging with free ions in solution. The rate of this exchange can be determined by certain electrolytic transference experiments involving the use of radioactive tracers. The theory of such transference experiments is worked out by formulating and solving appropriate differential equations subject to certain boundary conditions. It is then shown how results of these transference studies can be used for evaluating ion rate exchange constants. A

541.64 : 541.133.

7652. Electrolytic properties of aqueous solutions of polyacrylic acid and sodium hydroxide. III. The rate of sodium ion exchange between polyacrylate and free sodium ions. F. T. WALL, P. F. GRIEGER, J. R. HUIZENGA AND R. H. DOREMUS. *J. Chem. Phys.*, 20 1206–11 (*Aug.*, 1952).

The exchange of free Na ions with Na ions bound to polyacrylate ion has been investigated by an electrolytic transference method. On the assumption that there is a single exchange process, rate constants have been computed and the theory has been found

o provide a moderately good representation of the lata. A much better correlation is obtained, how-ver, if it is assumed that there are two exchange processes, one very rapid and the other very slow. Presumably the sodium ions that exchange rapidly belong to the polyacrylate ion atmosphere while those hat exchange slowly are located within the coiled olymer ion. The distribution of Na ions between hese two groups has been computed. A.

LABORATORY APPARATUS 542.1/.7

542.231.7

7653. Laboratory rubber connections. J. JACKSON. *Lab. Pract.*, **1**, 55–7 (*May*, 1952).

542.41 : 621.365.4

7654. A high temperature sintering furnace. J. H. RENDALL. *J. Sci. Instrum.*, **29**, 248–50 (*Aug.*, 1952).

A laboratory furnace is described in which specimens 75 mm long, 15 mm dia. can be heated to 2400°c either in hydrogen or in a vacuum better than 10^{-4} mm of mercury. The electrical-resistance heater is a fabricated tungsten tube 150 mm long, 35 mm dia. The furnace can be heated to or cooled from high temperature in <10 min and the specimen can be lowered into or raised from the hot zone while the furnace is at temperature. As the furnace contains no refractory materials to absorb heat, it rapidly attains the equilibrium temperature corresponding to a particular power input. A.

542.48

7655. Some characteristics of Stedman packing in the distillation of hydrogen and its isotopes. A. FOOKSON, P. POMERANTZ AND S. ROTHBERG. *J. Res. Nat. Bur. Stand.* [*Wash.*] **47**, 449–55 (*Dec.*, 1951).

Apparatus was designed and constructed in which some characteristics of Stedman packing in the distillation of hydrogen isotopes were measured. The average still hold-up and the hold-up at various boil-up rates were measured using both hydrogen and deuterium as still charge. Mixtures of hydrogen–hydrogen deuteride of known composition were distilled at boil-up rates of 454 millilitres per hour and 1 190 millilitres per hour, respectively. From the distillation data the height equivalent to a theoretical plate was calculated and found to be 1·0 in for the 12 in packing used in these experiments. A.

542.7

7656. Sodium pump for purification of inert atmospheres. L. A. BROMLEY, R. K. EDWARDS AND R. L. MCKISSON. *Rev. Sci. Instrum.*, **23**, 342–4 (*July*, 1952).

A liquid Na pump and contacting tray are described and recommended for the removal of oxidizing gases from inert atmosphere working chambers. The inert gas is circulated over streams of molten Na on the contacting tray. With this apparatus it is easy to obtain an atmosphere whose reactivity is less than the best vacuum in which comparable manipulations may be accomplished. A.

CHEMICAL ANALYSIS 543/545

543.712

7657. A sensitive method for the detection of traces of water in oil. J. E. C. STRINGER. Letter in *Nature* [*Lond.*] **169**, 1109 (*June* 28, 1952).

The derivation for the expression for the wetness of an oil given in Abstr. 4720 (1952) is acknowledged to be incorrect. Recalculated values for the water content of the oils quoted are given using a correct value for the density of acetylene. The humidiscope readings are in wide disagreement with the recalculated values. S. WEINTROUB

545.8 : 539.16.08

7658. Radioactivation determination of zirconium in Zr–Hf mixtures. J. E. HUDGENS, JR AND H. J. DABAGIAN. *Nucleonics*, **10**, 25–7 (*May*, 1952).

The amount of Zr present in a given sample is determined by pile irradiation followed by measurement of the 35-day and 90-hr Nb^{95} activities so produced. The Nb^{95} results from the decay of Zr^{95} produced in the irradiation. Microgram quantities of Zr in a flux of 10^{12} n/cm²/sec yield readily measurable Nb^{95} activities. The chemical separation of the Nb from the irradiated sample is described.

L. R. SHEPHERD

545.8 : 539.16.08

7659. Assay of uranium-bearing ores by fission analysis. W. W. HAPP AND J. L. HORWOOD. *Science*, **115**, 622 (*June* 6, 1952).

An ore sample mixed with ZnS phosphor was bombarded with slow neutrons from a 50 mc Ra–Be source, and the fission scintillations were observed with a photomultiplier. The method appeared unsuitable for routine analysis. F. R. HOLT

545.822

7660. The use of self-absorbing spectral lines in quantitative determination of rubidium. A. HALPERIN AND S. SAMBURSKY. *J. Opt. Soc. Amer.*, **42**, 475–80 (*July*, 1952).

A quantitative analysis of salts of the Dead Sea for their Rb contents was carried out. It was found necessary to use the resonance lines of Rb (at 7800; 7948 Å) as analysis lines. To eliminate the effect of extraneous elements on the ratio of intensities of the Rb line and the internal standard line, the method of quantitative addition was chosen. This method could not be used without correction for the strong self-absorption of the Rb resonance lines. Taking into account this self-absorption, a corrected formula was deduced, and with this correction the analyses were carried out with good results for concentrations of RbCl from 0·005% to 0·1%. A.

545.822

7661. An analysis of the factors in spectrochemical microanalysis. J. K. HURWITZ. *J. Opt. Soc. Amer.*, **42**, 484–8 (*July*, 1952).

Microanalytical apparatus has been designed and constructed for the purpose of the study of diffusion in metals and alloys and the analysis of segregates and inclusions. Versatility in changing photographic plate and sample speeds was included in the design. Based on mechanical considerations, the relative importance

of factors, such as size of sparked area, lengths of spectrograph and microphotometer slits and the ratio of plate speed to sample speed are discussed. The width of the sparked area was 0·6 mm and uniform. Calculations of apparent concentration were performed to verify the experimental discrimination factors. The most important factor was found to be the width of the sparked area. No advantage was seen in using a speed ratio greater than 10 : 1. A.

545.822

7662. Spectrochemical determination of tantalum and columbium in 18 Cr–8 Ni stainless steel. W. J. Poehlman and R. E. Sarnowski. *J. Opt. Soc. Amer.*, **42**, 489–91 (*July*, 1952).

A spectrographic method for the determination of the strategic and critical elements Ta and Nb, covering the concentration ranges 0·01 to 0·40% and 0·30 and 1·25%, respectively, is described. Samples are excited by an a.c. arc discharge using the point-to-plane technique. A prism-type spectrograph is employed, and the resulting spectrograms are recorded on calibrated emulsions. Utilizing the iron matrix as an internal standard, photographic photometry readings and intensity ratio comparisons are made for the analytical line pairs 3311·16 Ta *v.* 3165·86 Fe and 3299·61 Cb *v.* 3165·01 Fe. Included in the discussion are referee analyses, comparisons, working curves and standards. The analytical results of this method indicate adequate sensitivity, precision, accuracy and range of analysis for this type of material. A.

545.824

7663. Intensity calculation for determining weight percentage in a binary alloy by X-ray fluorescent analysis. P. K. Koh, B. Caugherty and R. E. Burket. Letter in *J. Appl. Phys.*, **23**, 698 (*June*, 1952).

Gives, without derivation, a simple formula for analysis of a binary alloy by X-ray fluorescent analysis, and experimental results on FeCo alloys.

A. E. DE BARR

CRYSTALLOGRAPHY 548

548.0 : 535 : 548.73

7664. Optical and X-ray data on a group of isostructural uranium and plutonium compounds. E. Staritzky and J. Singer. *Acta Cryst.*, **5**, 536–40 (*July*, 1952).

A group of isostructural compounds of hexavalent and tetravalent uranium and plutonium with tetraethyl and tetramethyl ammonium chloride (types = $(R_4N)_2MCl_6$ and $(R_4N)_2MO_2Cl_4$) have been characterized by their optical properties and by X-ray diffraction analysis. Some errors in earlier data have been corrected and explained. The isostructuralism is maintained throughout the group, as evidenced by both crystal morphology and X-ray crystallography, although the space groups range from cubic to monoclinic. The monoclinic crystal has a β-angle of 90·0°. A.

548.2

7665. Crystal forms of chromium orthophosphate. B. M. Sullivan and H. F. McMurdie. *J. Res. Nat. Bur. Stand.* [*Wash.*] **48**, 159–62 (*Feb.*, 1952).

548.232.2 : 548.73

7666. The lamellar structure of certain microcline and anorthoclase. T. Ito and R. Sadanaga. *Acta Cryst.*, **5**, 441–9 (*July*, 1952).

The interlamination on a microscopic to submicroscopic scale of different felspars in microcline and anorthoclase has been studied using Weissenberg photographs (Co $K\alpha$, $\lambda = 1{\cdot}79$ Å) and the results have been correlated with those of chemical analysis. They are all composed of two or more discrete member-crystals, one being monoclinic or triclinic and potash-rich, and the remainder triclinic and soda-rich. The constants of the direct and reciprocal lattices of each component felspar are given. Soda felspars are either albite- or pericline-twinned according as the γ^* or γ angle of the reciprocal or direct lattice is 90°. Further, the possible relationship between the bulk composition of a felspar belonging to the potash–soda series and twinning of the soda felspars produced from it upon exsolution has been surmised. The triclinic symmetry of the potash component of microcline has been confirmed. A.

548.24 : 537.2

7667. The influence of electric field on the twin structure of crystals of Rochelle salt. M. A. Cherny sheva. *Dokl. Akad. Nauk SSSR*, **81**, 1065–8 (*No.* 6 1951) *In Russian.*

In an electric field of 40–60 volts/mm poly synthetically twinned crystals of Rochelle salt at once become single crystals. With 12–15 volts/mm the transformation is relatively slower. The orientation of the derived single crystal depends on the field direction. On removing the field twinning is gradually re-established, but after a strong field has been applied the re-establishment is not always complete the twinning is often coarser than before. For fields of 3·5 volts/mm twinning is only partially removed and on taking off the field is fully re-established.

A. L. MACKA

548.

7668. Crack formation on sodium chloride single crystal surfaces. R. A. Lad. Letter in *J. Appl. Phys* 23, 800–1 (*July*, 1952).

Cracks were shown up by evaporating silver, gold or zinc on to the surfaces, and taking photomicrographs. They show a number of preferred direction

A. R. STOKE

548

7669. An optical method of studying imperfection in crystals. S. Goldsztaub and R. Kern. *Bull. Soc. Franç. Minér. Crist.*, **75**, 297–302 (*April–June*, 195 *In French.*

The crystal, illuminated by parallel light, is viewed so that only those parts oriented within 5′ of

particular direction are seen. A study of natural and artificial NaCl crystals has been made. A. R. STOKES

548.5

7670. The self-perpetuating step in crystal growth from the melt. B. CHALMERS AND U. M. MARTIUS. Letter in *Phil. Mag.*, **43**, 686–7 (*June*, 1952).

A step-like structure can reproduce itself continually if there is a temperature gradient; thus growth is possible without dislocations. A. R. STOKES

548.5

7671. The study of crystal growth with the electron microscope. II. The observation of growth steps in the paraffin *n*-hectane. I. M. DAWSON. *Proc. Roy. Soc. A*, **214**, 72–9 (*Aug.* 7, 1952).

For Pt I, see Abstr. 6561 (1951). Examination of the paraffin *n*-hectane in the electron microscope has given evidence of two different growth mechanisms for crystals of this compound. The one corresponds to the spiral growth mechanism already observed for *n*-hexatriacontane and the orthorhombic lozenge-shaped crystals of *n*-hectane show the typical spiral growth steps already described. The other growth mechanism gives rise to lath-shaped crystals and operates when growth takes place by the slow evaporation of a cold solution of *n*-hectane in xylene. The laths are invariably twinned across the diagonal of the orthorhombic cell, and growth in one direction is greatly accelerated by the occurrence of an indestructible step at the twin boundary. A.

548.5

7672. A model for epitaxy in metal–rock salt pairs. D. G. ENGEL. Letter in *J. Chem. Phys.*, **20**, 1174 (*July*, 1952).

The existence of a metal–salt monolayer between the salt substrate and the metal deposit is taken into account in lattice misfit considerations. Some experimental support for this model is given.

J. A. FRANKS

548.5 : 535.345.1–15

Growth and infrared transmission of cesium iodide crystals. *See Abstr.* 7179

548.5 : 548.736.1

7673. Formation, growth and structure of silver in thin films of silver bromide under the action of electrons. J. J. TRILLAT. *Acta Cryst.*, **5**, 471–3 (*July*, 1952) *In French.*

Polycrystalline and single-crystal thin films of AgBr have been formed by evaporation in vacuum on to various supports, and these films have been studied by electron diffraction. Under the influence of electrons of energy 45–55 kV microcrystalline Ag is formed, the quantity depending on the thickness of the film, the intensity of the electron beam and the structure of the AgBr crystals. The Ag crystals are always very small and are, in general, orientated at random even when derived from a single crystal of AgBr. The same is true of the Ag formed chemically by the action of a photographic developer. Particular features of the AgBr films are discussed. A.

548.535

7674. The habit plane of the zirconium transformation. A. J. J. VAN GINNEKEN AND W. G. BURGERS. Note in *Acta Cryst.*, **5**, 548–9 (*July*, 1952).

Crystals of Zr, cooled from above their transition temperature and etched, showed surface traces indicating {569} as the probable habit plane.

A. R. STOKES

548.55

7675. Techniques for growing and mounting small single crystals of refractory compounds. F. ORDWAY. *J. Res. Nat. Bur. Stand.* [*Wash.*] **48**, 152–8 (*Feb.*, 1952).

An apparatus is described for growing single crystals in a small droplet of melt at temperatures up to 1 600°C. The droplet, held by capillarity at the junction of a thermocouple, can be observed during the process through a binocular microscope. The heating is by means of a high-frequency current that can be separated by a filter from the thermocouple electromotive force, allowing the electromotive force to be measured continuously. The apparatus is therefore suitable also for determining melting points. The process of mounting and grinding the single-crystal specimens for X-ray diffraction and a simple but versatile micromanipulator to facilitate these procedures are described. A.

548.58

7676. Observations regarding resistant surface films of crystals. N. HAST. *Ark. Fys.*, **4**, 535–9 (*Paper* 37, 1952).

When crystals such as NaCl, or $CaCO_3$, dissolve in a solvent or a reagent, a veil-like membrane is left behind. By electron-microscopic photographs made and studied stereoscopically the form of this resistant surface film can be studied. The films are seen to have a porous structure of threads through which the material of the crystal diffuses during the process of dissolution; they can be formed in the absence of air, and as a tentative hypothesis it is suggested that they are formed from the ions of impurity present during crystallization. The paper is illustrated by stereo-photographs which are viewed through red and blue glasses provided. S. J. GREGG

MOLECULAR AND X-RAY CRYSTALLOGRAPHY 548.7

548.7

7677. Quantum-mechanical computations of the lattice energy and the lattice constant of LiF crystals. J. YAMASHITA. *J. Phys. Soc. Japan*, **7**, 284–6 (*May–June*, 1952).

The electronic state of F^- ion in LiF crystals was calculated by means of the variational method with the use of the analytical wave-function of 2p type with three parameters for the outermost electrons of F^- ion. The charge distribution of negative ion is seen to be somewhat contracted within the crystal. The lattice energy, the lattice constant and the compressibility of LiF crystals are found to become of 239 kcal/mol, 2·00 Å and $1{\cdot}96\times10^{-12}$ cm²/dyne respectively, which results are compared with the observed values of 240 kcal/mol, 1·99 Å and $1{\cdot}4\times10^{-12}$ cm²/dyne respectively. A.

548.7

7678. Lattice imperfections of diamond. P. G. KLEMENS. Letter in *Phys. Rev.*, **86**, 1055 (*June* 15, 1952).

Thermal conductivity measurements favour Ahearn's hypothesis of clusters of imperfections [Abstr. 1772 (1952)]. A. R. STOKES

548.7 : 539.11

Quantum mechanics of the body-centred transition metals. *See Abstr.* 7440

548.73

7679. Nomenclature of X-ray diagram lines. B. K. AGARWAL. *Sci. Cult.*, **17**, 479–80 (*May*, 1952).

It is suggested that the nomenclature be rationalized. The Greek letters α, β, ... would represent the change 1, 2, ... in total quantum number, an Arabic subscript to the Greek letter would give the sub-shell of the initial state, and an Arabic superscript would give the sub-shell of the final state. Thus the line resulting from the transition $P_{II} \rightarrow L_I$ (in Siegbahn's notation $L\gamma_{14}$) would be $L\delta_{\frac{1}{2}}$. A table comparing the notations of Sommerfeld, Siegbahn and the author is given. [In the abstractor's opinion it would be more reasonable to interchange the subscript and superscript, so that the upper number corresponded to the initial state, and the lower number to the final state.] A. J. C. WILSON

548.73

7680. The determination of the electron density in complex compounds in the crystalline state. G. S. ZHDANOV AND Z. V. ZVONKOVA. *Zh. Eksper. Teor. Fiz.*, **22**, 356–9 (*No.* 3, 1952) *In Russian.*

In electron density syntheses F_{000} can be estimated as equal to the greatest negative density observed (excluding F_{000} from the synthesis). If heavy atoms are present diffraction effects lead to an overestimation of F_{000}. A better method is to normalize so that heavy maxima have correct values. This is particularly useful for syntheses designed to find the electron distribution in bonds. A. L. MACKAY

548.73/.74 : 539.26/.27

X-ray and electron investigation of materials. *See Abstr.* 7594–98

548.732

7681. Theory of diffuse scattering of X-rays by local lattice distortions. T. MATSUBARA. *J. Phys. Soc. Japan*, **7**, 270–4 (*May–June*, 1952).

A general formula for the diffuse scattering of X-rays is derived for the crystal which has a local lattice distortion due to any kind of lattice defect. The intensity is expressible in terms of the Fourier transform of the potential energy parameters, similar to that introduced by Begbie and Born in their theory of diffuse scattering by lattice vibrations, and that of external forces causing the distortion. It is shown that our diffuse scattering may be observed in some crystals in which the density of the lattice defect exceeds a certain value. A.

548.732 : 535.42

Diffraction geometry. *See Abstr.* 7205

548.733 : 535.339 : 537.531

Point focusing X-ray monochromator for the study of low angle diffraction. *See Abstr.* 7312

548.734.8

7682. Intensity of X-ray diffraction by a one-dimensionally disordered crystal. I. General derivation in cases of the "Reichweite" $S = 0$ and 1. J. KAKINOKI AND Y. KOMURA. *J. Phys. Soc. Japan*, **7**, 30–5 (*Jan.–Feb.*, 1952).

Shows the calculation of the intensity of X-rays diffracted by a one-dimensionally disordered crystal by the matrix method of Hendricks and Teller (1942) and has two purposes: to make clear the relation between the above mentioned matrix method and the difference equation method used by Wilson (1942) and Jagodzinski (1949) and to rearrange the results obtained by Hendricks and Teller by introducing the general intensity equation from a rather simple and intuitive standpoint, assuming a finite number N of layers. The obtained result for the former is $\overline{S_j S_j^*}_{+n} = \text{spur } \boldsymbol{VFP}^n$. For the latter case, it is concluded that the matrix Φ containing the phase shift $\exp(-i\phi_s)$ is not a general matrix but a diagonal one, and the assumption of a finite number N of layers gives rise to a higher term in addition to the normal diffuse term and this higher term becomes the Laue function in special cases and can hardly be neglected at and near a special point and also when N is very small. In addition the physical meanings of some quantities which appeared in their paper are made clear. A.

548.734

7683. Asymmetric X-ray reflexion from natural quartz crystals. P. GAY. *Acta Cryst.*, **5**, 525–30 (*July*, 1952).

The variation of integrated intensity with the asymmetry of the reflection has been determined for two natural quartz crystals. It is shown that the results are in agreement with the theoretical predictions of the dynamical theory; further it is shown that experimental measurement of structure amplitudes can be made from these experiments with a higher degree of accuracy than hitherto. A.

548.734

7684. X-ray diffraction by face-centered cubic crystals with deformation faults. M. S. PATERSON. *J. Appl. Phys.*, **23**, 805–11 (*Aug.*, 1952).

In view of the recent interest in the introduction of stacking faults in crystals during plastic deformation the X-ray diffraction effects have been calculated for face-centred cubic crystals with deformation faults (as distinct from growth faults, the expressions for which are given in an appendix for comparison). Explicit expressions are derived for the reciprocal lattice intensity distribution, and it is shown how the intensity of faulting can be determined from measurements on the breadths of the reciprocal lattice streaks or the displacements of their peaks. It is then shown how these effects will be revealed in the X-ray powder pattern and some practical aspects are discussed. A

548.734.3 : 539.18

7685. The powder diffraction intensities of graphite for X-rays and neutrons. G. E. BACON. *Acta Cryst.*, **5**, 492–9 (*July*, 1952).

Measurements are reported of the powder diffraction intensities of graphite for both X-rays and

neutrons, with due allowance for crystallite orientation, thermal vibrations and the rhombohedral modification. The neutron intensities agree with those calculated from the Bernal structure to within 5%, thus showing that discrepancies in X-ray intensities must be mainly due to the inadequacy of the James and Brindley f curve. Comparison with the curve given by McWeeny suggests a certain, but only small, asymmetry of electron distribution. The neutron intensities, although confirming the Bernal method of layer stacking, cannot decide for or against Lukesh's proposed slight distortion of the carbon hexagons. A.

548.734.8

7686. Tables of absorption factors for spherical crystals. H. T. EVANS, JR AND M. G. EKSTEIN. *Acta Cryst.*, **5**, 540–2 (*July*, 1952).

Correction of single-crystal X-ray diffraction intensity measurements for absorption in the crystal is greatly simplified if the crystal is ground into a sphere. The factor by which the intensity of a diffraction beam is reduced by absorption is a function then only of the dimensionless product of the linear absorption coefficient and the radius of the sphere, and the Bragg angle 2θ. Tables are given in this paper which give the absorption factor in terms of the two variables. The tables are analogous to the standard tables for cylinders. A.

548.735

7687. On the relations between Fourier and least-squares methods of structure determination. D. W. J. CRUICKSHANK. *Acta Cryst.*, **5**, 511–18 (*July*, 1952).

A criterion for determining atomic co-ordinates in the Fourier method, applicable to resolved or unresolved peaks, is introduced. The full equations for co-ordinate refinements according to this criterion are shown to have an exact similarity with the normal equations of least squares for the function $R = \Sigma w(|F_0| - |F_c|)^2$, where F_0 and F_c are the observed and calculated structure amplitudes for reflections $i(=h, k, l)$, $w(h)$ is a weight function, and the sum is taken over the observed orders h. A criterion for finding atomic co-ordinates from the Patterson density leads to refinement equations which are similar to the normal equations for the function $R_2 = \Sigma w''(|F_0|^2 - |F_c|^2)$, where $w''(h)$ is another weight function. Both centrosymmetric and non-centrosymmetric space groups are considered. Approximate forms of the equations and the relationship of this work to earlier work by Booth, Cochran and Cruickshank are discussed. A.

548.735

7688. The diffraction of X-rays by a random assemblage of molecules having partial alignment. H. D. DEAS. *Acta Cryst.*, **5**, 542–6 (*July*, 1952).

The medium considered consists of molecules or other like particles (e.g. micelles) of which one direction, called the molecular axis, has a probability distribution $D(\alpha)$ as in a fibre, i.e. depending only on the angle α between the molecular axis and a direction fixed in space, the fibre axis. Random orientation of the molecules about their molecular axes and random distribution of their centres is assumed. The intensity distribution for X-ray diffraction by this medium is expressed in Fourier space in terms of the intensity distribution (Patterson transform) of the single molecule. Two examples are given, one of which contains as a special case the previously determined effect of finite linear gratings in random orientation. A.

548.735

7689. A graphical method for applying the Harker–Kasper inequalities to structure determination. K. SAKURAI. Note in *Acta Cryst.*, **5**, 546–8 (*July*, 1952).

A chart was constructed for reading off inequalities of the form $xy \geqslant k^2$. The different amounts of information obtained in given cases are discussed. A. R. STOKES

548.735

7690. Correction charts for Lorentz and polarization factors in anti-equi-inclination photographs. G. KARTHA. Note in *Acta Cryst.*, **5**, 549–50 (*July*, 1952).

The method of calculation and a reproduction of the chart are given. These photographs are convenient for highly absorbing needle- or plate-shaped crystals. A. R. STOKES

548.735.4

7691. A device for calculating structure factors. W. L. BRAGG. *Acta Cryst.*, **5**, 474–5 (*July*, 1952).

A simple device is described for calculating structure factors of the form $\Sigma f \cos(\sin) 2\pi hx/a \,.\, \cos(\sin) 2\pi ky/b$. Dials on a pivoted table are set so as to create moments proportional to the terms, and the sum is obtained by restoring the balance with an applied torque. The machine is compact and robust, and experience has shown it to be accurate and convenient to operate. A.

548.735.44

7692. Invariant characteristics of X-ray Fourier syntheses. A. D. BOOTH. Letter in *Nature* [*Lond.*] **169**, 1058 (*June* 21, 1952).

A consideration of the information to be obtained by averaging the electron density, or its square, over all possible combinations of phases of the reflections. A. R. STOKES

548.736.1

7693. The crystal structure of solid chlorine. R. L. COLLIN. *Acta Cryst.*, **5**, 431–2 (*July*, 1952).

The crystal structure of chlorine is based on space group D_{2h}^{18}–*Cmca* with four molecules in a unit cell of $a = 6{\cdot}29$, $b = 4{\cdot}50$ and $c = 8{\cdot}21$ Å. The bond distance within the molecule is 2·02 Å and the shortest non-bonded distance is 3·34 Å. A.

548.736.3/.4

7694. Lattice-spacing relationships in aluminium-rich solid solutions of the aluminium–magnesium and aluminium–magnesium–copper systems. D. M. POOLE AND H. J. AXON. *J. Inst. Met.*, **80**, 599–604 (*July*, 1952).

The lattice-spacing/composition relationship for the Al-rich Al–Mg solid solution has been re-investigated [see Abstr. 1360 (1948)], using two samples of Mg of different purities. Increasing the purity of the Mg reduces the curvature of the relationship at low concentrations of Mg and causes the linear portion of the curve to become more steep. The

Al-rich ternary Al–Mg–Cu solid solution has also been investigated, using Mg of high purity; in this solid solution there is a slight negative deviation from the additive effect which might be expected from Cu and Mg separately. A.

548.736.3

7695. The structure of sulphur nitride. D. CLARK. *J. Chem. Soc.* (1952) 1615–20 (*May*).

The crystal structure has been determined by X-ray analysis. The monoclinic cell contains four molecules S_4N_4, each consisting of a distorted tetrahedron of S atoms with N atoms along four edges. The distance between S atoms not joined through N is 2·58 Å, which is much shorter than the normal van der Waals' separation. Resonance formulae are suggested to account for this short S–S distance. A.

548.736.3

7696. Structure of the high-temperature modifications of CuBr and CuI. J. KRUG AND L. SIEG. *Z. Naturforsch.*, **7a**, 369–71 (*May*); *Erratum*, 445 (*June*, 1952) *In German.*

Powder photographs were obtained in a high-temperature camera. α-CuBr is cubic, $a = 4·56$ Å, stable between 470°c and the melting point, 488°c. It appears to be isotypic with AgI. β-CuBr is hexagonal, $a = 4·06$ Å, $c = 6·66$ Å, stable between 381 °c and 470°c. It appears to have the wurtzite structure, with some disorder in the placing of the Cu atoms. α-CuI is cubic, $a = 615$ Å, stable between 440°c and the melting point, 602°c. β-CuI is hexagonal, $a = 4·31$ Å, $c = 7·09$ Å, stable between 402°c and 440°c. The γ-forms have the zincblende structure (no details); the pyknometric density of γ-CuBr at 16°c is found to be 5·132–5·137, not 4·72 as given in the literature. A. J. C. WILSON

548.736.3

7697. The lattice spacings and densities of gold–nickel alloys at 25°c. E. C. ELLWOOD AND K. Q. BAGLEY. *J. Inst. Met.*, **80**, 617–19 (*July*, 1952).

Anomalies in lattice spacing and density have been found in the solid solution of Au and Ni. It is concluded that Brillouin-zone overlaps occur in the solid solution, accompanied by the formation of vacant lattice sites. By analogy with other Au-rich solid solutions and from the calculation by Jones and Mott (1937) of the $N(E)$ curve for the face-centred cubic metal Cu, it is concluded that Ni has a valency of 3·2 when dissolved in Au up to 60 at.%. A.

548.736.3

7698. The iron–nitrogen system: the crystal structures of ε-phase iron nitrides. K. H. JACK. *Acta Cryst.*, **5**, 404–11 (*July*, 1952).

At compositions near Fe_3N and Fe_2N the structures proposed for ε Fe nitrides by previous workers from incomplete X-ray data are confirmed. At intermediate N concentrations and at concentrations less than that of Fe_3N, additional superlattice reflections, unaccounted for by these previously proposed structures, are observed. Over the complete ε range, the true unit of structure (space group D_3^1–$C312$) has dimensions $a' = (2\sqrt{3})a$, $c' = c$; where a and c are the dimensions of the approximately close-packed hexagonal unit of the Fe–atom arrangement. The N atoms tend towards maximum separation an achieve considerable ordering at all concentration within the phase limits. The proposed structures a correlated with the observed unit cell dimension changes. In the ζ-Fe_2N structure the Fe atoms reta the same relative positions as in ε-Fe_2N, but becaus of a rearrangement of the N atoms, which in ζ a packed more closely in one direction, the Fe-ato lattice is anisotropically distorted. A mechanis for the ε-$Fe_2N \rightarrow$ ζ-Fe_2N transition is suggeste A discussion of the structural features of the Fe– system indicates that the interstitial-atom orderi shown by all phases except one, and particularly the α″ and ε phases, and the sharp change from o ordered arrangement (ε) to a different but equall ordered interstitial-atom arrangement (ζ) cannot b ascribed to ordinary close-packing or size factors.

548.736.

7699. Compounds of thorium with transition metal I. The thorium–manganese system. J. V. FLORI R. E. RUNDLE AND A. I. SNOW. *Acta Cryst.*, 449–57 (*July*, 1952).

Like U, Th forms no compounds with Cr, a fe with Mn, the number increasing through Ni, a decreasing sharply with Cu. The structures of t compounds of Th with Mn, reported in detail her are unlike those with Fe, Co and Ni, which a generally similar. $ThMn_2$ has the $MgZn_2$ (C14-typ structure; Th_6Mn_{23} is face-centred cubic with unique structure; while $ThMn_{12}$ is body-centre tetragonal with a structure similar to, but not identic with, the corresponding Fe, Co and Ni compounds.

548.736.

7700. Unidimensional disorder in SiC and its i fluence on the diffraction intensities of X-ray R. GEVERS. *Acta Cryst.*, **5**, 518–24 (*July*, 1952) *French.*

The theory is developed of the X-ray scattering b SiC crystals of the usual, 4-, 6- and 15-layer type which show order in two translation directions bu disorder in the third direction. A "4-layer influence for the 4- and 6-layer types, and a "6-layer influence for the 15-layer type is postulated. Furthermore, it put forward that four layers can never be arranged a hexagonal close-packed way, and five layers neve in a cubic way. The description of the disorder the needs one parameter α or two parameters α and β The intensity of diffraction is expressed in terms o two quantities x_n and C_n, which themselves depen upon α (or α and β), where α (α and β) is (are) th probability(s) that a fifth (seventh) layer continues cubic arrangement of the 4 (6) preceding layers. Th line widths and displacements of the positions o certain reflection maxima depend on the degree o order. Numerical data and comparison with exper mental results will be communicated later.

548.736.

7701. The crystal structure of the phase Cu_2C P. I. KRIPYAKEVICH, E. I. GLADYSHEVSKIĬ AND E. CHERKASHIN. *Dokl. Akad. Nauk SSSR*, **82**, 253– (*No.* 2, 1952) *In Russian.*

The crystal structure of the β-phase of the Cu–C system, which has the composition Cu_2Cd, has bee found from powder photographs. The compound

hexagonal with $a = 4{\cdot}95$ and $c = 7{\cdot}97$ KX : 00l and hl reflections are absent when l is odd; $Z = 12$. The structure is of the Zn_2Mg type (space group $C6/mmc$) having 4 Cd in (f) positions with $z \simeq 1/16$, 2 Cu in (a) and 6 Cu in (h) with $x \simeq 5/6$. Calculation of intensities confirms the structure. A. L. MACKAY

548.736.4

7702. The texture of single crystals of brucite. G. W. BRINDLEY AND G. J. OGILVIE. *Acta Cryst.*, **5**, 112–13 (*July*, 1952).

X-ray studies of single crystals of tabular brucite give no evidence of irregularities in the stacking sequence of the hexagonal layers of the structure. Rotation diagrams show both sharp spots and extended Debye–Scherrer arcs. They indicate a texture having a range of orientations of the c axis relative to the morphological c axis but with no rotation of the a axes around the c axis. Such a texture could arise from bending of the crystal lattice about $\langle 1\bar{2}10 \rangle$ directions and may be produced by a type of edge dislocation arising from additional planes of unit cells parallel to $\{10\bar{1}0\}$. A.

548.736.4

7703. The crystal structure of K_2AgI_3 and isomorphous substances. C. BRINK AND H. A. S. KROESE. *Acta Cryst.*, **5**, 433–6 (*July*, 1952).

K_2AgI_3 is orthorhombic with cell dimensions: $a = 19{\cdot}52$, $b = 9{\cdot}98$, $c = 4{\cdot}74$ Å. The axial ratios are in agreement with the values derived by Penfield from crystallographic measurements, if his b axis is halved. There are four molecules in the cell and the space group is *Pbnm*. Weissenberg diagrams have been taken along the c axis with Mo $K\alpha$ radiation and the positions of the atoms have been fixed by "trial and error" and by a Fourier projection along the c axis. The structure is closely related to that of K_2CuCl_3. All atoms lie in two symmetry planes perpendicular to the c axis. There are chains of composition AgI_3 in the direction of the c axis, with structure analogous to the chains in K_2CuCl_3, although their packing is quite different. The surroundings of the potassium ions are very similar. In both structures they are situated between the chains and are surrounded by six halogen ions at the corners of a trigonal prism and one more halogen ion on a lateral face. Rb_2AgI_3 and $(NH_4)_2AgI_3$ are approximately isomorphous with K_2AgI_3 and are shown to have the same structure. A.

548.736.5

7704. Crystal structure of the intermetallic compound $Mg_{32}(Al, Zn)_{49}$ and related phases. G. BERGMAN, J. L. T. WAUGH AND L. PAULING. Letter in *Nature* [*Lond.*] **169**, 1057–8 (*June* 21, 1952).

A structure was built up from considerations of likely numbers of nearest neighbours, and was verified by X-ray single-crystal diffraction data. It has a body-centred cubic cell with 162 atoms. A. R. STOKES

548.736.5

7705. The crystal structures of $(NH_4)_2CuCl_3$ and $(NH_4)_2CuBr_3$. C. BRINK AND A. E. VAN ARKEL. *Acta Cryst.*, **5**, 506–10 (*July*, 1952).

$(NH_4)_2CuCl_3$ is orthorhombic with $a = 14{\cdot}71$, $b = 22{\cdot}07$, $c = 4{\cdot}08$ Å. There are eight molecules in the cell and the space group is *Cmmm*. As in K_2CuCl_3 and in K_2AgI_3, all the atoms lie in two symmetry planes perpendicular to the c axis. The positions of the atoms have been fixed by Patterson and Fourier projections along the c axis. Both optical syntheses with Huggins masks and calculation with Beevers–Lipson strips were used. The structure is related to those of K_2CuCl_3 and K_2AgI_3 and contains the same type of chains of composition $CuCl_3$, formed by $CuCl_4$ tetrahedra sharing corners. Between these chains parallel to the c axis, three of the NH_4 ions are surrounded by eight Cl at the corners of a distorted cube and one NH_4 ion is surrounded by six Cl at the corners of a distorted trigonal prism and two more Cl on a lateral face at a somewhat greater distance. $(NH_4)_2CuBr_3$ is isomorphous with K_2CuCl_3, so each NH_4 ion is surrounded by seven Br, six at the corners of a distorted trigonal prism and one on a lateral face. A survey is given of those crystal structures of composition $A^1_2B^1(\text{Hal.})_3$ thus far investigated. A.

548.736.5 : 535.375.1

On the structure of phosphors of the aluminium oxide–calcium fluoride type activated with manganese. *See Abstr.* 7184

548.736.6

7706. The structure of β(AlMnSi)–Mn_3SiAl_9. K. ROBINSON. *Acta Cryst.*, **5**, 397–400 (*July*, 1952).

The structure of Mn_3SiAl_9 is similar to that of Co_2Al_5 with Mn and Si atoms replacing Co and Al atoms, respectively. The major difference between the two structures is that two atomic sites per unit cell, occupied by Co atoms in Co_2Al_5, are vacant in Mn_3SiAl_9. The structural similarity of the two compounds [and of the π(AlFeNi) phase] is accounted for in terms of a prominent Brillouin zone with an inscribed Fermi distribution corresponding to $1{\cdot}68$ electron states per atom. It is suggested that the "holes" in the structure of Mn_3SiAl_9 occur so as to preserve an electron/atom ratio in the neighbourhood of $1{\cdot}68$. The transitional metal atoms must effectively reduce the total number of electron states, the extent of this effect being estimated to be $4{\cdot}1$, $2{\cdot}6_5$, $1{\cdot}8_5$ and $0{\cdot}6_5$ states per atom for Mn, Fe, Co and Ni, respectively. Raynor's suggestion that the reduction in the total number of electron states is due to absorption of otherwise free electrons into vacancies in the 3d orbitals of the transitional metal atoms receives qualitative support. A.

548.736.6

7707. The structure of afwillite, $Ca_3(SiO_3OH)_2 . 2H_2O$. H. D. MEGAW. *Acta Cryst.*, **5**, 477–91 (*July*, 1952).

The structural formula of afwillite (empirically $3CaO . 2SiO_2 . 3H_2O$) may best be written $Ca_3(SiO_3OH)_2 . 2H_2O$. Silicon occurs in isolated tetrahedra, but with OH instead of O at some of the corners. The calcium co-ordination is 6 or 7, and the rather irregular calcium polyhedra share edges with each other and with silicon tetrahedra in the y direction. There are hydrogen bonds which fall into two groups of mean length $2{\cdot}52$ Å and $2{\cdot}72$ Å. The environment of one water molecule is approximately tetrahedral, of the other a plane triangle. The

structure was determined by three-dimensional Fourier methods, and distances are generally correct to less than 0·05 Å. The accuracy is discussed, with special attention to the rate of refinement of a non-centrosymmetric structure. Electron distribution at the centre of the atom is well represented by $A \exp[-pr^2]$, where p is close to 10 for Ca, 9 for Si, and 8 for O; the temperature factor is small. A.

548.736.6

7708. The crystallography of nickel kieselguhr. R. B. Roof, Jr. Letter in *J. Chem. Phys.*, **20**, 1181–2 (*July*, 1952).

548.736.6

7709. The elucidation of a new structure for silicon carbide—SiC VII. E. B. Gasilova, M. S. Beletskiĭ and M. I. Sokhor. *Dokl. Akad. Nauk SSSR*, **82**, 57–60 (*No.* 1, 1952) *In Russian.*

A 27-layer structure for silicon carbide has been found. The extinctions are: for $h - k \neq 3m$, $l = 3t$; for $h - k = 3m$, $l \neq 27t$, m, t, $= 0, 1, 2 \ldots$ and the space group is $R3m$. The packing arrangement is (2.2.2.3)3. The existence of packing types (2.2.2.2.2.3)3 and (2.2.2.2.2.2.2.3)3 with 39 and 51 layers respectively is predicted. A. L. MACKAY

548.736.6

7710. The elucidation of the crystal structure of SiC VIII. E. B. Gasilova and M. I. Sokhor. *Dokl. Akad. Nauk SSSR*, **82**, 249–52 (*No.* 2, 1952) *In Russian.*

An 8-layer silicon carbide has been found with a packing arrangement 4.4. The space group is $C6mc$ and the extinctions are: for $h - k \neq 3m$, not extinguished; for $h - k = 3m$, $l \neq 8t$ (m, t, $= 0, 1, 2, \ldots$). This structure has been mentioned by Ramsdell and Kohn [*Acta Cryst.*, **4**, 75 (*No.* 1, 1951)]. A. L. MACKAY

548.737

7711. Data on the investigation of crystals of dianthracene. N. E. Nechaeva, A. N. Faĭdysh and O. P. Kharitonova. Letter in *Zh. Eksper. Teor. Fiz.*, **22**, 380–1 (*No.* 3, 1952) *In Russian.*

Reported fully in *Trudy Inst. Fiz. Akad. Nauk Ukr. SSR, No.* 2 (1952). M.pt. 275–280°; orthorhombic, $a = 8{\cdot}40$, $b = 12{\cdot}10$ and $c = 19{\cdot}12$ Å; $Z = 4$; $2V = 60°$; $\alpha = 1{\cdot}673$; $\gamma = 1{\cdot}703$. Scattering and luminescence spectra are like those of anthracene. A. L. MACKAY

548.737

7712. Phase determination in the X-ray diffraction patterns of complex crystals and its application to protein structure. J. D. Bernal. Letter in *Nature* [*Lond.*] **169**, 1007–8 (*June* 14, 1952).

A method is proposed for eliminating many combinations of phases on the grounds that there can be no very large concentrations of electron density anywhere in a protein molecule. A. R. STOKES

548.737

7713. Phthalic anhydride [crystallographic data]. M. B. Williams, W. P. Van Meter and W. C. McCrone. *Analyt. Chem.*, **24**, 911–12 (*May*, 1952).

Crystal morphology, cleavage, X-ray diffraction data, density, optical and fusion data are given.

548.73

7714. Crystal structures of two para-substitute phenylpropionic acids. A. L. Patterson and J. F Clark. Letter in *Nature* [*Lond.*] **169**, 1008 (*June* 1 1952).

Cell dimensions and general descriptions of th chlorine- and bromine-substituted compounds ar given. A. R. STOKE

548.73

7715. Determination of crystal structure by optic diffraction methods. A. W. Hanson, C. A. Taylo and H. Lipson. *Nature* [*Lond.*] **169**, 1086–7 (*June* 2 1952).

A short description of the determination of th structures of *p*-di-*iso*cyanobenzene, diphenylene naph thacene, thiourea dioxide and di-*p*-anisyl nitric oxid by methods already described [Abstr. 7385, 9141 (1951), 4757 (1952)]. A. R. STOKE

548.73

7716. Purpurogallin: by optical diffraction method C. A. Taylor. *Nature* [*Lond.*] **169**, 1087 (*June* 2 1952).

See preceding abstract. Inspection of the weighte reciprocal lattice gave immediately the orientation the benzene-ring part of the molecule. A tri structure was tested by optical diffraction and slightl modified; the optical method then gave the corre signs for most of the structure amplitudes, which we finally used in a Fourier synthesis by calculation. A. R. STOKE

548.73

7717. Purpurogallin: by X-ray Fourier synthesi J. D. Dunitz. *Nature* [*Lond.*] **169**, 1087–8 (*June* 2 1952).

Trial-and-error methods were used to obtain Fourier synthesis of the (001) projection; this agre well with Taylor's structure (see preceding abstract A. R. STOKE

548.73

7718. The crystal structure of hydroxy-L-prolin I. Interpretation of the three-dimensional Patterso function. J. Donohue and K. N. Trueblood. *Ac Cryst.*, **5**, 414–18 (*July*, 1952).

The methods used in preparing and interpreti the three-dimensional Patterson function of hydrox L-proline are described in some detail. No chemic assumptions were made during the interpretatio The structure obtained from this Patterson analys was sufficiently accurate to confirm the chemic structure, and to be used in subsequent Fourier an least-squares refinements.

548.73

7719. The crystal structure of hydroxy-L-prolin II. Determination and description of the structu J. Donohue and K. N. Trueblood. *Acta Crys* **5**, 419–31 (*July*, 1952).

The determination of the crystal structure hydroxy-L-proline, based on nearly complete da accessible with Cu $K\alpha$ radiation, confirms the chemic assignment of the relative configurations about t two asymmetric carbon atoms, and leads to t following intramolecular bond distances: carbox group: C_1–$O_1 = 1{\cdot}25$, C_1–$O_2 = 1{\cdot}27$, C_1–C_2

·52 Å; pyrrolidine ring: C_2–C_3 = 1·53, C_3–C_4 = ·50, C_4–C_5 = 1·52, C_5–N = 1·48, N–C_2 = 1·50 Å; ydroxyl group: C_4–O_3 = 1·46 Å. The crystal is eld together by a system of hydrogen bonds, with .f. . . . O_2 = 2·69, N . . . O_2' = 3·17, O_3 . . . O_1 = ·80 Å. The molecule is in the Zwitterion form. hese and various other structural features are iscussed. A.

548.737

7720. An X-ray diffraction determination of the hemical structure of colchicine. M. V. KING, J. L. DE RIES AND R. PEPINSKY. *Acta Cryst.*, **5**, 437–40 (*July*, 952).

X-ray measurements have been made on a number f colchicine derivatives, in a search for a crystal uitable for a structure analysis of the colchicine nolecule. The methylene bromide and iodide ddition complexes, $C_{22}H_{25}NO_6 . CH_2X_2$, are isomor- hous, in space-group $P2_12_12_1$, with 4 molecules in a ell of dimensions $a = 9·11$, $b = 14·87$, $c = 18·54$ Å or the bromide, and $a = 9·22$, $b = 15·05$, $c =$ 8·63 Å for the iodide. A straightforward analysis, tilizing the isomorphism and the non-negativity riterion for phase determination on X-RAC, led to -axis projections which confirmed the ring structure roposed by Dewar, involving one six- and two even-membered rings. The substituents are in ositions corresponding to those suggested by Čech nd Šantavy for colchiceine. The rather flat col- hicine molecules lie one above the other in columns, nd chains of hydrogen bonds link the columns ogether in pairs. The methylene halide molecules re held in discrete cages between the columns. A.

548.737

7721. The structure of urea. Interatomic distances nd resonance in urea and related compounds. P. VAUGHAN AND J. DONOHUE. *Acta Cryst.*, **5**, 530–5 *July*, 1952).

The interatomic distances in urea have been redetermined by Fourier and least-squares analysis f complete data obtained with Cu $K\alpha$ radia- tion. The results are C = O = 1·26 Å, C–N = 1·34 Å, ∠ N–C–O = 121°, N–H . . . O = 2·99 Å and N–H . . . O′ = 3·04 Å. Evidence for the position of he hydrogen atoms is found in the electron-density ections. Improved agreement of calculated with bserved structure factors was obtained by including he hydrogen scattering in the calculations, and by se of anisotropic temperature factors. Revised alues for carbon–oxygen and carbon–nitrogen ouble bonds are suggested, and these values are sed to discuss the effect of resonance on interatomic istances in urea and related compounds. A.

548.737

7722. The crystal structure of diphenyl diselenide. R. E. MARSH. *Acta Cryst.*, **5**, 458–62 (*July*, 1952).

The crystal structure of diphenyl diselenide has been determined by analysis of rotation and Weissenberg photographs about the b and c axes. The space group is D_2^4–$P2_12_12_1$; the unit cell dimensions are: $a = 24·07$, $b = 8·27$, $c = 5·64$ Å. There are four molecules in the unit cell. Positional parameters for he selenium and carbon atoms were assigned from Fourier projections on (001) and (010); the selenium parameters were then refined by least-squares calculations. The observed Se–Se distance is 2·29 ± 0·01 Å, which is 0·05 Å shorter than twice the normal single-bond radius for selenium. The selenium–carbon distances are close to the predicted value of 1·94 Å. A.

548.737

7723. The structure of haemoglobin. W. L. BRAGG AND M. F. PERUTZ. *Proc. Roy. Soc. A*, **213**, 425–35 (*July* 22, 1952).

Describes the first steps in an attempt to solve the structure of a haemoglobin molecule by X-ray analysis, using a direct method. It is based on an extensive series of absolute measurements of the diffraction by various shrinkage stages of a haemoglobin crystal, and estimates based on many crystalline forms of the general dimensions of the haemoglobin molecule. The methods used are described here and applied to a direct determination of the electron density in one particular direction in the molecule. The extension of the methods to the subsequent problem of obtaining a picture of the molecule as projected on a plane will, it is hoped, form the subject of a subsequent paper. A.

548.74

7724. Dynamical theory of electron diffraction for a finite polyhedral crystal. I. Extension of Bethe's theory. N. KATO. *J. Phys. Soc. Japan*, **7**, 397–406 (*July–Aug.*, 1952).

Bethe's dynamical theory of electron diffraction has been extended by an approximate treatment first to the case of a wedge-shaped crystal, next to the case of a wedge-shaped crystal covered by opaque screens with an aperture and finally to the most general case of a polyhedral crystal of finite extension. If the incident wave, $\Phi_I = \Psi_I \exp j(\boldsymbol{K}_I . \boldsymbol{r})$, impinges on the entrance surface, S_e, and the transmitted and diffracted (interfracted) wave leave the crystal from the exit surface, S_a, their wave functions are given as a superposition of plane waves; the transmitted wave: $\Phi_0(\boldsymbol{r}) = \sum_{i=1,2} \int \Psi_0^{(i)}(\boldsymbol{K}_0) \exp j(\boldsymbol{K}_0 . \boldsymbol{r}) d\boldsymbol{K}_0$ the diffracted wave: $\Phi_g(\boldsymbol{r}) = \sum_{i=1,2} \int \Psi_g^{(i)}(\boldsymbol{K}_g) \exp j(\boldsymbol{K}_g . \boldsymbol{r}) d\boldsymbol{K}_g$. Here, the amplitude functions, $\Psi_g^{(i)}(\boldsymbol{K}_0)$ and $\Psi_g^{(i)}(\boldsymbol{K}_g)$, are:—

$$\Psi_0^{(i)}(\boldsymbol{K}_0) = \Psi_I \int \frac{c^{(1)}c^{(2)}}{c^{(1)} - c^{(2)}} \cdot \frac{(-1)^i}{c^{(i)}} \cdot L(\boldsymbol{K}_I - \boldsymbol{k}_0^{(i)};\ S_e) \times L(\boldsymbol{k}_0^{(i)} - \boldsymbol{K}_0;\ S_a) d\boldsymbol{k}_0^{(i)}, \quad \text{and} \quad \Psi_g^{(i)}(\boldsymbol{K}_g) = \Psi_I \int \frac{c^{(1)}c^{(2)}}{c^{(1)} - c^{(2)}}$$

$(-1)iL(\boldsymbol{K}_I - \boldsymbol{k}_0^{(i)};\ S_e)L(\boldsymbol{k}_g^{(i)} - \boldsymbol{K}_g;\ S_a)d\boldsymbol{k}_g^{(i)}$, where $c^{(i)}$ is the amplitude ratio of the primary and secondary (interfracted) waves in crystal which are related to the i-branch of the dispersion surface, and $\boldsymbol{k}_0^{(i)}$ and $\boldsymbol{k}_g^{(i)} = \boldsymbol{k}_0^{(i)} + 2\pi\boldsymbol{g}$ are their wave vectors. The function L means the diffraction function due to an aperture S and expressed as $L(\boldsymbol{K} - \boldsymbol{k}; S) = \int_S \exp j(\boldsymbol{K} - \boldsymbol{k} . \boldsymbol{r}_s) d\boldsymbol{r}_s$. The most general expressions of the transmitted and diffracted waves for a finite polyhedral crystal are given as the sum of the waves mentioned above for every pair of the entrance and exit surface. A.

548.74

7725. Dynamical theory of electron diffraction for a finite polyhedral crystal. II. Fraunhofer formula. N. KATO. *J. Phys. Soc. Japan*, **7**, 406–14 (*July–Aug.*, 1952).

The general formula derived in Pt I was simplified by introducing an assumption that the wavelength of electrons compared with crystal size is very short. The simplified formula is more practical and directly applicable to the interpretation of the simple- and double-refraction as well as the Fraunhofer diffraction effects of Laue spot. A comparison of the dynamical and corresponding kinematical formulae shows that the concept of "Intensitätsbereich" as advocated by von Laue in his kinematical theory may be used in dynamical theory. Finally some numerical examples and comparison with theory and experiment are given. A.

GEOPHYSICS 55

550.311

7726. Problems of thermal instability in a sphere. H. JEFFREYS. *Mon. Not. Roy. Astron. Soc. Geophys. Suppl.*, **6**, 272–7 (*May*, 1952).

The theory of thermal instability in a sphere [Abstr. 9839 (1951)] is extended to the case of a viscous sphere with a fluid core, the radius of the core being half that of the outer surface. The easiest mode to excite no longer corresponds to a spherical harmonic of degree 1 in the temperature but probably to degree 3 or 4. A more satisfactory model from the petrological point of view is based on the idea of a magma percolating through a mass of incompletely consolidated crystals. Results are obtained for this case, both for a uniform sphere and for one with a core. The harmonics of degree 1 are not the easiest to excite in either case. The results are discussed in relation to the theory of the origin of the land and water hemispheres by thermal instability. A.

550.312

7727. A relation between density of a fluid mass and surface gravity. L. BRAGARD. *C.R. Acad. Sci. [Paris]* **234**, 2341–3 (*June* 9, 1952) *In French.*

Based on the classical integral equation for the potential of a uniformly rotating fluid mass, and on Green's transformation formula, a solution is obtained which gives a generalized relation between density, and surface gravity of the mass considered.

D. R. BARBER

550.341

7728. The effect of internal friction on the velocity of the superficial seismic wave with short period. P. CALOI. *Ann. Geofis.*, **4**, 469–73 (*Oct.*, 1951) *In Italian.*

A brief note comparing theoretical and experimental velocities for Rayleigh waves in a visco-elastic medium. Theory predicts an infinite velocity for waves with zero period dropping rapidly to the value for an elastic medium for periods of a few seconds, and the experimental data is quite consistent with this. J. M. HOUGH

550.361

7729. On the rise of temperature within the mantle of the earth through adiabatic compression. P. E. VALLE. *Ann. Geofis.*, **4**, 475–8 (*Oct.*, 1951) *In Italian.*

A brief note based on the Debye theory of specific heats calculating the maximum frequencies of longitudinal and transverse waves in an elastic medium subject to adiabatic compression, using a quantum mechanical expression for the entropy. Using accepted values of the maximum frequencies and the density it is calculated that the temperature at a depth of 2898 km is 1·24× the temperature at 1000 km. J. M. HOUGH

550.361

7730. On the adiabatic temperature gradient in the earth's interior. P. E. VALLE. *Ann. Geofis.*, **5**, 41–53 (*Jan.*, 1952) *In Italian.*

On the basis of the theory of an ideal isotropic solid body, and starting from seismic data, the ratio of the coefficient of the thermal expansion to the specific heat at constant pressure in the earth's mantle, has been calculated. It appears that the ratio decreases with increasing depth, going from $4{\cdot}8610^{-12}$ g erg^{-1} at the depth of 33 km to $0{\cdot}9510^{-12}$ g erg^{-1} near the bottom of the mantle. The adiabatic behaviour of the ratio T/T_{33} (T_{33} temperature at 33 km of depth) with varying depth, has been calculated and the approximate values of the gradient have been deduced. The similar ratio T/T_{2898}, referring to the *E* region of the core, has been estimated. A.

550.3

7731. The spectral distribution of the rapid variations in the telluric currents. Y. BEAUFILS. Note in *Ann. Geophys.*, **8**, 100–4 (*No.* 1, 1952) *In French.*

Results of the application of Fourier analysis to the rapid variations in telluric currents at three stations in France, Italy and Morocco. The frequency distribution shows a marked change between the hours of night and of day. J. M. HOUGH

550.381 : 523.7

7732. Relation between geomagnetic activity and solar radioelectric activity. J.-F. DENISSE. *Ann. Geophys.*, **8**, 55–64 (*No.* 1, 1952) *In French.*

From measurements of radiosolar noise made on 158 Mc/s it is possible to discriminate among solar active centres of intensity 2 and 3, those which will be followed, one or two days later, by an increase of the geomagnetic activity.

550.38

7733. Isolation of the undecennal variation of the horizontal component of the earth's magnetic field by linear combination of ordinates. P. BERNARD. *Ann. Geophys.*, **8**, 248–52 (*No.* 2, 1952) *In French.*

The curves of the periodic undecennal variation of H, obtained by Prof. Labrouste's method, are presented and discussed. It is emphasized that the are almost of the same amplitude when calculated with the calm days and with all days, a result difficult to explain by the classical post-perturbation effect.

550.384

7734. Rapid fluctuations of the geomagnetic field. G. GIBAULT. Note in *Ann. Geophys.*, **8**, 258–9 (*No.* 2, 1952) *In French.*

From an analysis of quick-run (3 mm/min) magnetograms it is found that the amplitude of micro-pulsations is normally greater by day than by night. The period of fluctuation ($\simeq$ 9 sec) is longer at night than during the day. The record is disturbed most often between 4–5 h U.T., the pulsations diminishing around 15 h. Micro-pulsations are rarely obsd. after 18 h, and never later than 22 h. D. R. BARBER

550.384 : 523.78

7735. Micro-magnetic variations during the solar eclipse of February 25, 1952. N. F. ASTBURY. *Nature* [*Lond.*] **170**, 68–9 (*July* 12, 1952).

Recordings of micro-pulsations of the horizontal geomagnetic force component, made with a large air-coil magnetometer, coupled to a d.c. amplifier and recorder, made at Khartoum during the total eclipse of February 25, exhibit a marked depression of the normal amplitude fluctuation (*c.* 100 gamma) of period 20–30 sec, there be a period of min. disturbance *c.* 10 min after totality followed by a prolonged (4–5 hr) recovery. Concurrent ionospheric records indicate correlation of the magnetic variability with changes in the ionized layers, possibly by plasma oscillations at the lower levels. D. R. BARBER

550.831

7736. The gravitational attraction of a deposit of clay. A. H. COOK. *Mon. Not. Roy. Astron. Soc. Geophys. Suppl.*, **6**, 243–51 (*May*, 1952).

On the basis of the study of the consolidation of clays made by Skempton (1944) and others, estimates have been made of the gravitational attraction of a deposit of clay. Examples of the behaviour of some typical clays are given and a procedure for correcting gravity anomalies for the attraction of a deposit of clay is suggested. A.

550.839

7737. Description of the equipment of a vehicle for γ-ray radiosounding. J. BERBEZIER, R. CHAMINADE AND C. LALLEMANT. *Ann. Geophys.*, **8**, 260–3 (*No.* 2, 1952) *In French.*

An automatic recording G.M. counter equipment for recording the γ-ray intensity as a function of depth in a bore hole is described. J. M. HOUGH

550.93

7738. Determination of geological time. R. L. BURLING. *Nucleonics*, **10**, 30–5 (*May*, 1952).

A basic survey of the radioactivity methods of estimating ages of geological systems. The interval which is measured is, in nearly all cases, that which has elapsed since the elements involved underwent separation into different phases. L. R. SHEPHERD

551.311.124

7739. Measurement of the velocity distribution along a vertical line through a glacier. J. A. F. GERRARD, M. F. PERUTZ AND A. ROCH. *Proc. Roy. Soc. A*, **213**, 46–58 (*July* 22, 1952).

Using an electric heating element, a vertical hole 37 m long was melted from the glacier surface to the rock-bed. The hole was lined with a 3 in steel tube which froze into the glacier and became tilted and bent according to the velocities prevailing at different depths. Using electrically recording pendulum instruments, the inclination of the tube at different depths was measured at the start of the experiment and again after one and two years. The rate of surface flow was found to be 35 m per year. Of this amount, roughly half seemed to be due to flow within the ice and the other half due to sliding of the glacier over its bed. The velocity decreased regularly from the glacier surface downwards, and there was no indication of a yield stress below which ice was completely rigid. If the assumption is made that the deformation of the ice in the glacier is due to simple shear stress, a tentative relationship between this stress and the rate of shear strain can be derived from the results. This shows that flow is not Newtonian, but approximates to a relation where $\gamma = 10^{-8}\tau^{1\cdot5}$ (γ = rate of shear strain per second, τ = shear stress in bars), over a range of τ between 0·1 and 0·75 bars. Comparison with laboratory compression tests by Glen (1952) indicates that the exponent of τ increases at shear stresses above 1 bar. A.

ATMOSPHERE . METEOROLOGY 551.5

551.501.7

7740. Remote opening and sealing of metal tubes. L. T. LOH, H. W. NEILL, M. H. NICHOLS AND E. A. WENZEL. *Rev. Sci. Instrum.*, **23**, 339–41 (*July*, 1952).

"One-shot" methods of opening and sealing metal tubes are described. These methods were developed for taking high altitude atmospheric samples in metal bottles carried aloft by rockets and are performed by pyrotechnic means. The sealing is done by cold welding. A.

551.508.71

7741. Theory of the lag coefficient of hygroscopic hygrometers. V. VÄISÄLÄ. *Ann. Acad. Sci. Fennicae*, *A*1, *No.* 112, 10 *pp.* (1952).

By considering first an unsaturated aqueous solution of a substance with an air flow over the surface and applying the results to a hair hygrometer considered as an unsaturated solution an attempt is made to show how the lag is dependent on temperature and on the relative humidity. The results are compared with observation. S. WEINTROUB

551.510.41

7742. A selective annotated bibliography on carbon dioxide in the atmosphere. N. A. STEPANOVA. *Meteorol. Abstr.*, **3**, 137–70 (*Feb.*, 1952).

551.510.41

7743. Abundance and vertical distribution of telluric methane from measurements at 3580 meters elevation. A. H. NIELSEN AND M. MIGEOTTE. *Ann. Astrophys.*, **15**, 134–41 (*No.* 2, 1952).

Spectrophotometric observations of i.r. lines, 0–1, 5–6, 10–11 of $2\nu_3$ band of atm. CH_4 at 1·6 μ, made on the Jungfraujoch, lead to a value for the total number of CH_4 molecules, above the mountain, as computed by Goldberg's method, consistent with the

latter's results for Lake Angelus and Mount Wilson, U.S.A., and also with his conclusion that the abundance of CH_4 decreases exponentially with height, and has a world-wide distribution. D. R. BARBER

551.510.41

7744. Some reactions occurring in the earth's upper atmosphere. D. R. BATES. *Ann. Geophys.*, **8**, 194–204 (*No.* 2, 1952).

The photochemical reactions determining the equilibrium between N_2, N, NO and NO_2 are examined and some general deductions are made. It is pointed out that the atomic O in the upper atmosphere acts as a catalyst assisting the reformation of molecular N. Reliable information on the degree of dissociation cannot be derived at present from the appearance of λ5199 in the airglow, or from the appearance of other N I lines, and N II lines, in aurorae since the reactions involved may be more complicated than has been supposed by some earlier workers. The origin of the N_2O in the atmosphere is discussed. A considerable yield is necessary to balance the loss due to photo-dissociation. Because of this many of the sources which have been advocated have to be dismissed. It is tentatively proposed that the gas may be formed in the troposphere by collision processes between O, or O_3, and N_2. A recent suggestion that N_2O is indirectly responsible for excitation of the Meinel hydroxyl bands is investigated. The conclusion reached is that the suggestion is unacceptable. A.

551.510.5 : 551.594.5

7745. Recent advances in auroral spectroscopy and in our knowledge of the upper atmosphere. L. VEGARD. *Ann. Geophys.*, **8**, 91–9 (*No.* 1, 1952).

Recent work here described or recalled confirms the theory of the upper atmosphere previously outlined by the author. Recent temperature measurements are given. A.

551.510.535 : 538.566.3

Radio-wave propagation in the ionosphere. *See Abstr.* 7433

551.510.535 : 551.593.5

7746. Ionospheric absorption by N_2 and O_2 of certain extreme ultraviolet solar wavelengths. K. C. CLARK. *Phys. Rev.*, **87**, 271–6 (*July* 15, 1952).

Measurements are reported of the coefficients of absorption by the gases N_2 and O_2 of the emission from the H Lyman series 2–7, the resonance line 584 Å of He I, and twenty lines of H_2 between 980 Å and 850 Å, the atomic lines likely being strong in solar radiation. For an atmosphere of constant relative composition the absorption coefficients are related to the atmospheric heights of maximum photoionization and maximum electron concentration by equations which allow for a constant temperature gradient, the inverse square decrease of gravity, and a recombination process which may vary with height. With these laboratory measurements for N_2 and O_2 and the known calculated absorption for O, ionosphere layer heights are computed for the simple case which assumes complete O_2 dissociation above 100 km, no N_2 dissociation, and two-body recombination. Although only the first assumption is probably secure, it appears that photoionization is capable of producing layers at heights which agree with observation. A.

551.510.535 : 551.594.12

7747. Action of solar radiation in the upper atmosphere. M. NICOLET. *Ann. Géophys.*, **8**, 141–93 (*No.* 2, 1952) *In French.*

Comprehensive survey dealing with the solar output of radiation (photospheric, chromospheric and coronal), and the absorption processes in the earth's atmosphere. Values are given for the absorption coeffs. of the main atmospheric constituents for the wavelength regions 3000–910 Å, <910 Å, and X-rays, and for the total solar flux available at the top of the earth's atmosphere. These data are used in discussing photo-ionization processes, assuming a model atmosphere. Chapman's ionization theory is modified to allow for variations of the scale height and of the coeff. of recombination with altitude. It is concluded that the E region (130 km) may be attributed to photo-ionization of O ($\lambda < 910$ Å), and the F1 region (200 km) to that of O and N ($\lambda < 660$ Å) if appreciable dissociation of N_2 be admitted. The D region (70 km) is probably associated with the ionization of NO ($\lambda < 1300$ Å). The twilight excitation of N_2^+ at 100 km may be attributed to ionization of N_2 by X-rays. G. M. BROWN

551.51

7748. Slow thermally or frictionally controlled meridional circulation in a circular vortex. A. ELIASSEN. *Astrophys. Norveg.*, **5**, 19–60 (*May*, 1952).

A quasi-static theory is given. The slow meridian circulation, superimposed on stable vortex motion arises from, and is completely determined by, an assumed distribution of sources of heat and angular momentum. Axial distance and pressure are taken as independent variables, and the stream function for the meridian motion is found to satisfy a generalized Poisson equation. The general nature of the motion is considered for certain simple source distributions. Applications of the theory to possible meridian currents in the earth's atmosphere are discussed. R. A. NEWING

551.513 : 536.25 : 523.1

Convection under terrestrial and astrophysical conditions. *See Abstr.* 6993

551.521.

7749. Investigation of global radiation. J. GOLD SCHMIDT. *Arch. Meteorol. Geophys. Bioklimatol. I* **3**, 244–55 (1951) *In German.*

Records of global sun and sky radiation from Moll–Gorczynski pile at Wahnsdorf are summarized. Values for different sun heights on cloudless days are compared with a simple formula $a_0 \sin h - b_0/\sin$ and constants determined for each month. Effects of duration of sunshine (% of possible) and cloudiness are then examined; close but not linear relations are found, especially with the former, and expressed as quadratic equations for year, summer and winter. Duration of sunshine is then introduced in a new comprehensive formula. METEOROLOGICAL ABSTRACT

551.521

7750. Intensity and spectral distribution of global radiation with a clear sky. F. ALBRECHT. *Arch. Meteorol. Geophys. Bioklimatol. B*, **3**, 220–43 (195 *In German.*

Discusses the theory and obtains a new compl

formula involving, in addition to solar elevation and earth's albedo, a constant depending on back radiation from the atmosphere. This constant is related to absorption by water vapour using observations in Gobi 1931–2, and to diffusion by opaque particles, which are considered to swell at high humidity. This constant is calculated from all available data, equator to pole, and relates values to turbidity factor. There can be large day-to-day changes. The observed spectral distribution of global radiation differs, but not greatly, from the theoretical distribution.

METEOROLOGICAL ABSTRACTS

551.525

7751. A study of the annual soil temperature wave. E. S. WEST. *Aust. J. Sci. Res. A*, **5**, 303–14 (*June*, 1952).

Soil temperatures recorded at Griffith (New South Wales) over an 8-year period at a depth ranging from 1 in to 8 ft have been examined and compared with air temperatures. The observed fluctuations in the soil temperatures fit closely the theoretical equation for the propagation of a simple harmonic temperature wave into the soil. The diffusivity of the soil has been deduced and compared with values found by other workers in other localities. The annual wave of the daily mean temperature at the surface of the soil has been deduced and compared with the annual wave of the daily mean air temperature and the differences in the means, amplitudes and phase displacements have been discussed. A.

551.573

7752. The rate of natural evaporation from shallow ponds. J. FERGUSON. *Aust. J. Sci. Res. A*, **5**, 315–30 (*June*, 1952).

The meteorological factors determining the rate of natural evaporation from "free" water surfaces are: the radiant energy supply from the sun and atmosphere, the air temperature in contact with the surface, the absolute humidity of the air, and the wind velocity and turbulence over the surface. The relevant relationship of these factors has been expressed in a differential equation, whose solution, given proper numerical instantaneous values of the determining factors and their variation with time, yields the value of the depth of liquid evaporated in a given period from small areas of shallow ponds of different depths. Using different values of the parameters, a number of solutions of the equation were obtained by means of a differential analyser. It is shown that, provided the depth of the water is greater than about 16 cm, a simpler equation using mean values of the radiant energy flux and the air temperature over short periods of time yields almost identical results. The use of this equation for the prediction of evaporation from shallow ponds exposed to known climatic conditions is discussed. A.

551.574.1

7753. A theory of the formation of ice crystals. H. K. WEICKMANN. *Arch. Meteorol. Geophys. Bioklimatol. A*, **4**, 309–23 (1951).

Summarizes theories and experiments on formation of ice crystals on nuclei and sets out a theory of "oriented overgrowth (epitaxy)." "Any suitable host crystal can orient an absorbed layer of H_2O molecules. By piling up other layers of H_2O molecules a very small ice crystal (ice seed) is created which can grow in supercooled water. Calculations of the effective temperature of mica, AgI and quartz are in fairly good agreement with experiment. This theory permits an explanation of the observed thresholds of ice formation which occur at about −20°, −30°, −40° and −60°C. Occasionally capillary condensation of water molecules on a freezing nucleus will occur when the vapour is saturated with respect to ice but not with respect to water. . . ."

METEOROLOGICAL ABSTRACTS

551.574.1

7754. New work on condensation nuclei. H. DESSENS, with the collaboration of C. LAFARGUE AND P. STAHL. *Ann. Geophys.*, **8**, 21–32 (*No.* 1, 1952) *In French.*

Condensation nuclei, whose diameter is generally less than 1 micron, were studied by electronic microscopy. They are built of hygroscopic salts among which sodium chloride seems the most active. A.

551.576

7755. Acoustic exploration of clouds. G. ZANOTELLI. *Ann. Geofis.*, **5**, 55–76 (*Jan.*, 1952) *In Italian.*

A method is described which enables the number of water droplets which are contained in the volume unit as well as their radius to be determined. It is based on the reflection of acoustic waves within the audible range owing to the simultaneous action of both the mechanical dragging effect of the water droplets following the acoustic displacement, and the thermodynamic effect of alternative condensation and evaporation of the droplets caused by the oscillation of the acoustic pressure. The acoustic reflection coefficient of a cloud bank has been determined; such a coefficient depends in characteristic manner upon the acoustic frequency, as well as on the radius and number of the droplets, and further on temperature and pressure. A.

551.578.1

7756. Evolution of a charged water drop in a cloud above 0°C. R. COCHET. *Ann. Geophys.*, **8**, 33–54 (*No.* 1, 1952) *In French.*

Various methods are examined to determine by calculation and graphically the coefficient of growth of an electrified water drop and next the growth of the drop in a fog. The general theory was verified experimentally in the particular case of cylinders, the trajectories of fog drops being photographed in the proximity of a charged cylindrical conductor. In the seeding of neutral clouds with water drops, electrified artificially or naturally, calculation showed that (1) the small electrified water drops increase in diameter rapidly in a short distance; (2) the electrification of water drops can in general act efficiently only on the initial stage which should start the precipitation. A drop of diameter 30 μ carrying a charge of 4×10^{-4} e.s.u. gives the same result as an uncharged drop of diameter 120 μ. For success in seeding the cloud must be of sufficient depth, possess an ascending current and be saturated and holding enough moisture to saturate layers below the cloud. R. S. READ

551.593.12

7757. Some experiments on the scintillation of stars and planets. M. A. ELLISON AND H. SEDDON. *Mon. Not. Roy. Astron. Soc.*, **112**, 73–87 (*No.* 1, 1952).

Cathode-ray oscillograms of stellar and planetary

scintillation have been recorded over a period of a year. For this investigation selected multiplier photocells (type RCA 931–A) of special sensitivity and high signal/noise ratio have been used at the Cassegrain focus of the 36-inch reflector of the Royal Observatory. The output voltages, after amplification, are applied to the beam of an oscillograph, the "Y-deflections" of the spot being recorded on moving film. The sensitivity and dark current of the cells and the time constant of the circuit are discussed. Scintillation in integrated light is exhibited as a function of altitude and of seeing conditions. Scintillation amplitudes of 5 to 10% are always present in the zenith, when recording with the full aperture of 36 in. The amplitude of scintillation is found to vary with telescope aperture A approximately in the ratio $1/A$, but appears to reach a maximum at an aperture near 3 in. Under normal conditions at this aperture, high-altitude stars show sudden flashes of light, lasting about one-hundredth of a second, which cause momentary increases in brightness of 1 to 2 magnitudes. The average size (3 in) and distance (5 km) of the atmospheric irregularities causing scintillation have been deduced from a comparison of the scintillation patterns of stars, planets and satellites. Some experiments on colour scintillation, using "monochromatic" light, are described. An attempt has also been made to imitate the main features of scintillation by generating refractional irregularities in a model atmosphere of water. A.

551.593.51

7758. On the spectrum of the green flash at sunset. T. S. Jacobsen. *J. Roy. Astron. Soc.*, **46**, 93–102 (*May–June*, 1952).

A microphotometric comparison was made of the intensity distribution in five green-flash and six low-sun diffraction camera spectra recorded on a colour movie film. The green flash was shown to be accompanied by an intensification of green light relative both to other colours in its own spectrum and to the green present in the low-sun spectrum taken 29 sec earlier. A.

551.593.9

7759. Reproducibility of Meinel's results relating to the night-sky spectrum around 8000–9000 Å. V. T. Lukashenya and V. I. Krasovskiĭ. *Dokl. Akad. Nauk SSSR*, **81**, 811–14 (*No.* 5, 1951) *In Russian.*

A critical survey of recent experimental work, showing that our actual data of infra-red night-sky spectrum are very accidental and contradictory.

F. LACHMAN

551.593.9 : 551.594.5

7760. Photometric observations of the airglow and of the aurora borealis at College, Alaska. D. Barbier and H. Pettit. *Ann. Geophys.*, **8**, 232–47 (*No.* 2, 1952).

These are discussed with special attention to the corrections for scattered light. The results are as follows: airglow, the intensity of the green line is about the same as is found in regions of moderate latitude while the D line and λ5210 are much weaker; aurora borealis, most of the observations of the green line indicate a height of 135 km, but a few give 750 km, the other two radiations seem to be emitted at high altitudes, some indication of the macroscopic structure of the observed aurorae is given. A.

551.593.9 : 551.594.5

7761. On the question of infrared radiation from the night sky and polar aurorae. B. A. Bagaryatskiĭ, V. I. Krasovskiĭ and M. I. Mordukhovich. *Dokl. Akad. Nauk SSSR*, **82**, 579–80 (*No.* 4, 1952) *In Russian.*

Gives tables of the intensity as a function of wavelength for the range 7800–10 100 Å. Four different sets of observations on the polar aurorae have been reduced and shown to have the same shape of curve, which is different from that for the night sky.

J. M. HOUGH

551.594.12

7762. Relation between temperature and the phenomena of dissociation or photochemical ionization in the upper atmosphere. Particular examination of the *E*-region. J. Gauzit. *Ann. Geophys.*, **8**, 226–31 (*No.* 2, 1952) *In French.*

In the upper atmosphere, by dissociation or ionization processes, atoms or electrons of high kinetic energy are created. Considering specially the photodissociation of O molecules, the calculated initial kinetic energy of O atoms corresponds to more than 3000°K for altitudes comprised between 100 and 130 km. A.

551.594.12

7763. The height of the atmospheric electrical sheath. H. Israël. *Ann. Géophys.*, **8**, 253–7 (*No.* 2, 1952) *In German.*

A continuation of previous work [Israël and Kasemir, *Ann. Géophys.*, **5**, 313–24 (1949)] in which the atmosphere is considered as being like a condenser whose plates are the earth and a concentric sheath where the maximum ionization occurs. The electron density is calculated as a function of height from data on the ionization due to cosmic rays and assuming some law for the variation of the coefficient of recombination as a function of pressure. It is shown that a variation proportional to the cube root agrees with experimental data and this leads to a value of 65 km for the height of the sheath.

J. M. HOUGH

551.594.1

7764. Measurements of large ions in the atmospheric air at Uppsala. R. Siksna. *Ark. Geofys.*, **1**, 483–51 (*Paper* 18, 1952).

These were made in all types of weather with an Israel large-ion counter. Full experimental details are given. The effect of limit mobilities on the number of captured ions is studied theoretically and a method is developed for deriving the mobility-spectra of the ions from the measurements, taking into account the end-effect of the counter. In addition to the large ions, the results show the presence of small intermediate ions due to this end-effect. The arrival of fresh air masses seems to cause the appearance of new bands at higher mobilities in the large-ion spectra while in undisturbed conditions the bands are displaced to lower mobilities. Explanations are advanced for the two effects. The majority of the large ions were located below a mobility of $2{\cdot}5\times10^{-4}$ cm/sec. Simultaneous measurement of the numbers of small ions with an Ebert counter showed a correlation

between the number of these ions, the number and spectral distribution of large ions and the weather conditions. A. E. KAY

551.594.13

7765. A new method of investigating ionic spectra in the atmosphere. E. K. FEDOROV. *Dokl. Akad. Nauk SSSR*, **82**, 717–18 (*No.* 5, 1952) *In Russian.*

A brief description of a method of obtaining a rapid value of the distribution curve of a number of ions against mobility. The measuring condenser is connected via a switch to a battery and the other plate connected via a resistance to earth. The potential across the resistance is studied as a function of time after closing the switch and the ionic spectral curve is deduced mathematically. J. M. HOUGH

551.594.14

7766. On the artificial radioactive products existing in the atmosphere of the Paris region. M. ABRIBAT, J. POURADIER AND A.-M. VENET. *C.R. Acad. Sci. Paris*] **235**, 157–9 (*July* 16, 1952) *In French.*

See also Abstr. 6938 (1952). Measurements from Dec. 1951 to June 1952 show the occurrence of a peak in May due to trials of atomic bombs in Nevada. The activity decays with the same law as that found near the seat of the explosion.

J. M. HOUGH

551.594.221

7767. On the mechanism of development of a lightning discharge. A. S. ALIZADE. *Zh. Tekh. Fiz.*, **21**, 652–7 (*No.* 6, 1951) *In Russian.*

Moving-image photographs of about 50 lightning discharges observed during 4 annual expeditions in mountainous regions of Azerbaijan have been analysed. Most of these consisted of multiple strokes, the maxm. being 33 strokes over a period of 1·45 sec; 89% were from negatively charged clouds and 3% from positively charged clouds, while in the remaining 8% the polarity changed during the discharge. Weak cloud-to-earth leader strokes were observed before only 5 of the first main earth-to-cloud discharges, and before only 38 of a total of 256 secondary discharges. It is, however, believed that very weak leaders may have preceded all the initial strokes, but may not have been detected owing to inadequate sensitivity of the recording apparatus. Of the 5 initial leaders recorded, 2 were branched and 3 were unbranched. The 2 branched leaders were from high clouds (>2 km) and the unbranched leaders from low clouds (<1 km). It is suggested that Schönland's observation that initial leaders are always branched is applicable only to level country, above which the clouds are fairly high. A close correlation was found between the velocity of propagation of the leader of a secondary stroke and the time-interval since the preceding stroke, the velocity being high (up to 25 000 km/sec) when the time interval is small. This is attributable to the effect of de-ionization of the discharge path between successive strokes. A. SCHOFIELD

551.594.5

7768. Spectra of northern lights in the infrared region. B. A. BAGARYATSKIĬ AND M. I. MORDUKHOVICH. *Dokl. Akad. Nauk SSSR*, **82**, 45–7 (*No.* 1, 1952) *In Russian.*

Describes four spectrograms of northern lights, obtained with the apparatus described by Krasovskiĭ [Abstr. 3597 (1949)] and extending to 11 000 Å. All 4 spectrograms display a high degree of coincidence. The radiation is grouped in: 7400–7600, 7650–7900 (with 2 distinct maxima: 7746–7774 and 7854–7882), 8000–8150 (distinct maximum at *c.* 8120), 8250, 8350–8500 (maxima *c.* 8320, 8380 and 8470), 8550–8950 (maxima 8680 and 8820), 9050–9300 (band at 9180), 9300–9550 (very weak), 9800–10 500) bands at 9976, 10 217 and 10 374), and 10 800 Å (weak).

F. LACHMAN

551.594.5 : 550.385

7769. Theories of the aurora polaris. S. CHAPMAN. *Ann. Géophys.*, **8**, 205–25 (*No.* 2, 1952).

Existing theories of magnetic storms and aurorae are outlined, and the present state of the mathematical theory of a neutral (ions + electrons) stream of solar gas, developed by Ferraro and the author, though regarded as being far from satisfactory, is considered in some detail. It is felt that a real though limited progress towards an acceptable theory of magnetic storms has already been achieved; but much less towards a comprehensive theory of the aurora. D. R. BARBER

551.596.5

7770. On the origin of the rumbling of thunder. G. ZANOTELLI. *Ann. Geofis.*, **4**, 453–67 (*Oct.*, 1951) *In Italian.*

It is suggested that the long persistence and characteristic sound of thunder is caused by selective reflection in clouds rather than by reflection from hills, etc. Two mechanisms for the selective reflection are suggested: (1) evaporation and condensation of the water drops due to the sound pressure and (2) the effect of the water drops on the viscosity of the air.

J. M. HOUGH

BIOLOGY 57/59

578.088.5

7771. A study in recovery after irradiation with X-rays. P. LAMARQUE. *J. Chim. Phys.*, **48**, 252–6 (*May–June*, 1951) *In French.*

The author considers the term "recovery" from effects of ionizing radiations needs to be qualified. Biological experiments with silk worm eggs demonstrate how doses and fractionation time can be chosen to take advantage of the recovery time. Metabolic activity of the cell affects the recovery time; this is shown by experiments with cells at 0°C, when recovery after irradiation is almost zero. For the particular case of two successive irradiations separated by 8 hours, it is shown that the recovery factor is best

utilized when 2/3 of the total dose is given in the first application, and 1/3 in the second. D. V. MABBS

578.088.5

7772. Recovery pattern of the blood picture in guinea pigs following a limited total body exposure to chronic gamma radiation. E. LORENZ. *J. Chim. Phys.*, **48**, 264–74 (*May–June*, 1951).

This is an interim report on a series of experiments in which guinea pigs receive whole-body irradiation with γ-rays (8·8 r in 8 hours daily). Complete blood counts were made frequently during irradiation which ceased when the red cell count fell to 2·8 million per mm^3. Thereafter the blood counts were continued, and all are clearly recorded graphically together with those of control animals. Results are divided into 3 groups according to survival time, and the phases of decline or recovery are discussed. Bone-marrow pictures from each group are shown, and correlated with the blood counts. It is noted that effects of chronic and acute dosages are comparable in the case of spleen and other lymphoid structures, but differ strikingly for bone-marrow. D. V. MABBS

MEDICAL SCIENCE . HUMAN PHYSIOLOGY 61

612.014.462.481

7773. Action of beta rays from P^{32} on human skin. A. BOSE. Letter in *Sci. Cult.*, **17**, 444–6 (*April*, 1952).

Blotting-paper P^{32} applicators are applied to 5 different sites on a human forearm. After varying lengths of time, each applicator is removed, and skin reactions are noted and presented as a table. An estimate of the dosages concerned in roentgens is evolved, and a summary of the corresponding degrees of reaction is given. D. V. MABBS

612.843.21

7774. The electrophysiological methods of analyzing colour reception. R. GRANIT. *Comm. Int. Eclair.* [*CIE*] 12*th Mtg*, 1951. *Volume* 2, *Paper K*, 8 *pp.* (1952).

A summary of work on the sensitivity of the retina to colour, using a micro-electrode to pick up the response from individual fibres of the optic nerve. The discovery of "dominators" and "modulators" in the mechanism of the response to different wavelengths is described. J. W. T. WALSH

612.843.31

7775. Retinal colour processes caused by intermittent white light. K. MOTOKAWA AND M. EBE. Letter in *Nature* [*Lond.*] **170**, 79–80 (*July* 12, 1952).

The method of electric phosphenes [Motokawa, *J. Neurophysiol.*, **12**, 291, 475 (1949)] was used to study the effect of the temporal variation of the excitation voltage after illumination of 1° of the central fovea with intermittent white light. A variation in the interval between the two flashes produced three sets of curves which could also be found on varying the flash duration. These measurements are claimed to be the physiological counterparts of the subjective colour effects described by Fechner and Benham. Two figs. are given. R. A. WEALE

612.843.3

7776. The photopic luminosity curve for a group o fifteen Egyptian trichromats. I. G. H. ISHAK. *J. Opt Soc. Amer.*, **42**, 529–34 (*Aug.*, 1952).

The photopic luminosity function for fifteen Egyptian observers with normal colour vision ha been measured every 100 Å between 0·41 μ an 0·46 μ by the direct comparison method and betwee 0·46 μ and 0·70 μ by the flicker technique on Wright' colorimeter. Two humps at about 0·45 μ and 0·48 have been noticed but are more pronounced than thos found by previous investigators. An analysis of th present data and the more important previou investigations has been made. It was found that th discrepancies among the different results could b partly accounted for by differences in the obser vational conditions and differences in the densities o the yellow macular pigmentation among the observers The results also confirm Jacobsen's finding that th C.I.E. luminosity function is low at the blue end o the spectrum.

612.843.3

7777. The spectral chromaticity coordinates for on British and eight Egyptian trichromats. I. G. H ISHAK. *J. Opt. Soc. Amer.*, **42**, 534–9 (*Aug.*, 1952).

The spectral chromaticity co-ordinates have bee measured at intervals of 0·01 μ between 0·41 μ an 0·70 μ by means of Wright's colorimeter for on British observer and for eight Egyptian observer with normal colour vision. The matching stimu were spectral radiations of wavelengths 0·65 μ 0·53 μ and 0·46 μ. The units were based on spectra lines 0·5825 μ and 0·494 μ (Wright's system) t eliminate the effect of the yellow ocular pigmentation Individual differences were noticed which were to large to be accounted for by experimental errors an may be due to differences in the visual mechanism The student t test was applied to examine the signif cance of the differences between the means of th co-ordinates of the Egyptian group and four Britis observers. No significant difference was foun between the means of the red co-ordinates, but highly significant difference was noticed in the blu and green co-ordinates. It was also noticed that th difference was in such a direction that the green wa higher and the blue lower in the Egyptians than i the British. Comparison has also been made betwee the average Egyptian data with those of Wrigh Guild and Weaver; Abney, and the C.I.E. after th transformation of their data to Wright's system.

612.843.6

7778. Pupil size as determined by adapting lumi ance. S. G. DE GROOT AND J. W. GEBHARD. *J. Op Soc. Amer.*, **42**, 492–5 (*July*, 1952).

Available measurements by different investigato on the relationship between pupil diameter a luminance of large adapting fields were compiled a weighted for the number of observers used. T equation for the curve that best fits eight sets of da is $\log d = 0{\cdot}8558 - 0{\cdot}000401\,(\log B + 8{\cdot}1)^3$, whe d is the diameter of the natural pupil in millimetr and B is the luminance of the adapting field in mil lamberts. This is the best estimate that can be ma to date of the pupil size—luminance relationship. make the data of more general use they were correct

for the Stiles–Crawford effect and expressed so that retinal illuminance, adjusted for average pupil size, may be obtained directly from knowledge of the luminance of the stimulus field. The expression for this is $\log E(\text{trolands}) = \log B + 1{\cdot}8614 - 0{\cdot}000986 (\log B + 6{\cdot}5)^3$, where E is the retinal illuminance in trolands and B is luminance in millilamberts. It is unfortunate that no extensive measurements have been made in this important area. A.

612.843.611

7779. The effect of high intensity and short duration *versus* low intensity and long duration of intermittent pre-exposure upon human dark adaptation. F. A. MOTE AND E. C. REED. *J. Opt. Soc. Amer.*, **42**, 521–5 (*Aug.*, 1952).

The influence of intermittent pre-exposure upon subsequent dark adaptation was investigated for two intermittent conditions. In one condition the intensity was increased in the same proportion as the amount of light-time in the light-dark ratio was decreased, keeping duration constant. In the other, intensity was constant but the duration was extended to compensate for variations in light-time. Both conditions were compared with equivalent control pre-exposures to continuous light. The control intensities and durations were 140, 281 and 562 mL and 1 and 3 minutes. The rate of intermittence was 1 c/s, and four light-to-dark ratios were used. The curves of dark adaptation obtained after intermittent pre-exposures of constant duration but different intensities were almost identical with those after the equivalent control pre-exposure. This was not so for the intermittent pre-exposures of constant intensity but different durations; after the longer durations, dark adaptation was much slower than after the equivalent control condition. A.

612.843.611

7780. Dark adaptation and miners' nystagmus. N. J. W. FERGUSON AND F. W. SHARPLEY. *Comm. Int. Eclair.* [*CIE*] 12*th Mtg*, 1951. *Volume* 2, *Paper* 2*e*, 6 *pp.* (1952).

The adaptation threshold was measured for a large number of miners, some suffering from nystagmus, and for a group of non-miners. It was found that the threshold was higher for underground workers generally and that there was some indication of a still higher threshold for those suffering from nystagmus.

J. W. T. WALSH

612.843.612

7781. The visibility of black objects against an illuminated background. M. A. BOUMAN AND H. W. M. BLOKHUIS. *J. Opt. Soc. Amer.*, **42**, 525–8 (*Aug.*, 1952).

Measurements in terms of the total average number of quanta that must be intercepted from the background by a flash of various durations, shapes and sizes in order to perceive a "negative" flash are presented for rod vision 7° nasal from the fovea. It is proved that the results are fairly well described by quantatheoretical observations on the dependence of the absolute threshold on the visual angle of the test spot and the flashtime and such observations on the behaviour of the contrast threshold. A.

612.843.614 : 628.972

7782. Illumination and the variation of visual performance with age. H. C. WESTON. *Comm. Int. Eclair.* [*CIE*] 12*th Mtg*, 1951. *Volume* 2, *Paper C*, 10 *pp.* (1952).

A discussion of the observed differences in the performance of a specified visual task according to the age of the subject. Each task was performed at 6 different levels of illumination covering a range of 1 000 to 1. The effect of changing the illumination was found to increase with advancing age, but it was not found possible, within the range covered, to compensate for age by increase in the illumination. An age basis is suggested for the values prescribed in codes of illumination. J. W. T. WALSH (R)

612.843.63

7783. Investigation of the applicability of Landolt's C as a standard in visual acuity measurements. H. SCHOBER. *Optik*, **9**, 225–35 (*No.* 5, 1952) *In German.*

Landolt's C is used in a thorough investigation of its value in the measurement of absolute acuity. The errors are analysed statistically and answers purporting to give a "seen" position diametrically opposite the correct one occur more frequently than any other. Amongst the "diametrical" errors, the horizontal and vertical positions occupy minima. These significant irregularities are explained on a psychological basis.

R. A. WEALE

612.843.721

7784. The influence of surround and luminance on the perception of the size of objects. N. GÜNTHER. *Optik*, **9**, 222–4 (*No.* 5, 1952) *In German.*

Expressions are derived for the apparent size of an object in terms of its real distance and the radius of the observer's space of accommodation. The latter is a function of the apparent pupil diameter and the resolving power of the eye. The increased size of the moon (and sun) near the horizon is cited as an example. R. A. WEALE

612.845

7785. The characteristics of tritanopia. W. D. WRIGHT. *J. Opt. Soc. Amer.*, **42**, 509–21 (*Aug.*, 1952).

The paper describes how contact was made with a number of tritanopes through an article published in an illustrated weekly English journal. Seventeen cases of tritanopia were tested and confirmed at the Imperial College, London, and of these, seven made detailed observations on the author's colorimeter. The measurements included the relative luminous efficiency of monochromatic radiation through the spectrum (the luminosity curve), the dichromatic spectral coefficient curves, the spectral mixture curves, the tritanopic confusion loci in the C.I.E. chromaticity chart, and the wavelength discrimination curve. The results support the theory that tritanopia is due to the absence of blue receptors, although the location on the chromaticity chart of the fundamental stimulus associated with the blue process has not yet been determined with precision. From the readership statistics of the journal and from an analysis of the correspondence received as a result of the article, it is estimated that the incidence of tritanopia lies somewhere between 1 person in 13 000 and 1 in 65 000, and that the ratio of men to women tritanopes

is of the order of 1·6 to 1. The transmission of the defect appears to differ from that found for protanopia and deuteranopia. A.

612.846

7786. Vision with a stabilized retinal image. R. W. Ditchburn and B. L. Ginsborg. Letter in *Nature* [*Lond.*] **170**, 36–7 (*July* 5, 1952).

When a suitable optical system is used the retinal image of a test-object can be stabilized. Such an image is found to disappear from view at intervals; also the contrast threshold is greatly increased. This suggests that spontaneous eye movements are of sensory importance. Three figs. are given.

R. A. WEALE

612.846.2

7787. Binocular eye movements when convergence is subjectively changed. M. P. Lord. Letter in *Nature* [*Lond.*] **169**, 1011–13 (*June* 14, 1952).

The photoelectric corneal reflex method [Abstr. 5828 (1949)] was used to investigate eye-movements during voluntary convergence in steps of equal angles. They are characterized by saccadic rotations, composed of subjective convergence and relaxation, the average magnitude of each (horizontal) component being 1° for both eyes. A sinusoidal trace ($f = 0{\cdot}88$ c/s) is obtained for the vertical component. Two observers have similar characteristics: a third shows very large movements. The data are discussed in terms of ocular dynamics. One fig. is given.

R. A. WEALE

612.85

7788. Do you auralize? D. W. Martin. Letter in *J. Acoust. Soc. Amer.*, **24**, 416 (*July*, 1952).

It is suggested that the verb "auralize" and its companion noun "auralization" would be useful for describing mental impressions of sound not yet heard, in analogy with "visualize." G. F. HODSMAN

612.85

7789. Remarks on the determination of a differential threshold by the so-called *ABX* technique. J. D. Harris. Letter in *J. Acoust. Soc. Amer.*, **24**, 417 (*July*, 1952).

The advantages of the method in difficult discriminations or with complex stimuli are mentioned but the chief disadvantage is claimed to be that *ABX* is too complicated, involving a compound judgment, and does not therefore yield the finest measures of sensitivity. G. F. HODSMAN

614.485

7790. Hygienic indications for the use of ultraviolet radiation in lighting practice. H. E. Ronge. *Comm. Int. Eclair.* [*CIE*] 12*th Mtg*, 1951. *Volume* 2, *Paper Z*, 8 *pp.* (1952).

States the various effects of u.v. irradiation, particularly its part in the production of vitamin D. This is especially important in northern latitudes, and in the case of children or adults working in rooms with little daylight, supplementary u.v. radiation is recommended. The different methods available for supplying this are examined. The conditions under which u.v. radiation can profitably be used for bactericidal purposes are stated. J. W. T. WALSH

614.89

7791. Protection against X-rays by cyanide and nitride of sodium. A. Herve, Z. M. Bacq and H. Betz. *J. Chim. Phys.*, **48**, 256–7 (*May–June*, 1951) *French.*

Mice are irradiated in groups of 10 with 700 r u 230 kV X-rays. Death occurs in all cases, 4–10 day afterwards. When mice receive intra-peritonea injections of 0·1 mg NaCN, a survival of 50–80% i observed after the same X-ray dose. 0·1 mg NaCN administered 15 minutes after irradiation produce no decrease in mortality and in the light of this, th possible action of the CN radical as a protective agen is discussed. NaN_3 produces similar effects. Result are based on observations of 11 groups of mice.

D. V. MABE

614.89

7792. Protection of biological systems from th effects of ionizing radiation. L. F. Nims. *J. Chim Phys.*, **48**, 280–3 (*May–June*, 1951).

It is impossible to protect biological systems fro the physical effects of ionizing radiation. Protectio can be achieved against some of the chemical oxida tions resulting from radiation but the protectin substances must be present during the exposure fo the major protective effect. Further studies on th biological mechanisms damaged by radiation giv some hope of developing a rational therapy for th radiation syndrome.

614.89

7793. The concept of a maximum permissibl exposure. R. S. Stone. *Radiology*, **58**, 639–61 (*Ma* 1952).

The annual Carman Lecture to the Radiologica Society of North America; a full account of a aspects of the subject. The conception and evolutio of a "tolerance dose" is followed through to i latest form. The deleterious effects of radiations o the skin, blood and haemopoietic tissues are describe with many factual examples. Doses which will caus leukaemia and malignant tumours, cataract forma tion, impaired fertility and genetic effects are co sidered, and the opinions and results of many worke are provided, some in tabulated form. On the bas of present knowledge, any amount of radiation, n matter how small, causes some biological effect, an it is desirable, therefore, to keep exposure to radiatio to the lowest possible level. An extensive bibliograp is appended. D. V. MAB

614.8

7794. The safe disposal of contaminated extract a from radioactive laboratories. J. W. J. Fay. *Atomi* [*Lond.*] **3**, 143–8 (*June*, 1952).

The hazards arising from the disposal of air fro dry boxes and fume cupboards in which acti material is released in aerosol form are examine Stack dilution and settling out of particles from sta gases are discussed, consideration being given to r entry of exhaust air into the laboratory. Particul references are made to Pu^{239} and Sr^{90}. It is conclud that handling of 1-mc quantities of the common emitters presents no hazard, but at the 100-r level the provision of a stack is desirable. A fil may be necessary to remove particles $>10\ \mu$ diamet

L. R. SHEPHE

614.898

95. Ventilation requirements for power reactor mpartments. W. O. PASSARELLI, JR. *Nucleonics*, , 46–9 (*June*, 1952).

The contamination of air in a reactor compartment e to leakage of coolant from a closed circuit is amined. The coolant activities arising in a thermal ater-cooled reactor employing stainless steel ducts e listed with estimated breathing tolerances. Curves e derived showing permissible coolant leakage rates a function of time for the airborne activity to reach lerance level, both for continuous and 1 hr/week posure of personnel. The effects of intermittent rging and continuous ventilation and filtering of e compartment air are considered. L. R. SHEPHERD

615.849

96. Multicurie cobalt 60 units for radiation erapy. A. MORRISON, W. R. DIXON, C. GARRETT, E. JOHNS, L. M. BATES, E. R. EPP, D. V. CORMACK ID S. O. FEDORUK. *Science*, **115**, 310–12 (*March* 21, 52).

The authors consider briefly the advantages of gh-energy radiation, in particular that from Co^{60}. aking use of the high neutron flux available in the nadian pile it is possible to get Co^{60} sources with ecific activities from 20–60 curies/g. Two 1 000 ries sources have been made and incorporated in erapy units, the detailed design of each unit being scribed. The output of both is 33 r/min at 80 cm d the dose distribution compares with that from MeV X-radiation. L. E. MUSSELL

615.849

97. Measurement of beta-ray applicators. J. ASTNER AND L. GREENBERG. *Radiology*, **58**, 731–9 *lay*, 1952).

Measurement is made for an ophthalmic β-ray plicator, and it is shown, by microphotometer trace an autoradiograph, that the surface dose rate varies pidly even over this small diameter (5·6 mm). An inite parallel-plate ionization chamber is described; th it, the total energy absorbed in cellulose acetate eets of various thickness is measured, and thereby e energy absorbed at any depth in tissue is obtained. ne distribution of this energy in each layer is easured by an autoradiograph, and the absolute lue of the energy at any point is derived. Tissue dose curves with values in rep/minute are given for e applicator. The method is adaptable for sources om 10 μC to 100 mC. D. V. MABBS

615.849 : 537.533 : 621.384.613

98. The 31-MeV betatron installation at the iversity Radiological Institute attached to the Zurich ntonal Hospital. A. VON ARX. *Brown Boveri Rev.*, , 273–80 (*Sept.–Oct.*, 1951).

Gives technical details of a betatron installation for ncer therapy, which has been in use since April, 51. Over 40 patients were treated in the first nonths of use. Details of beam intensity techniques e given and with an applied dose of 300 r the posure time is 4–15 min, depending on the field and get-skin distance. J. D. CRAGGS

615.849 : 537.533 : 621.384.613

99. Adaptation of 31-MeV betatron to medical plications, and shielding problems. G. JOYET AND W. MAUDERLI. *Brown Boveri Rev.*, **38**, 281–91 (*Sept.–Oct.*, 1951).

Briefly discusses the physical processes involved in the absorption of high-energy radiations in matter, notably in living tissues and then proceeds in detail to study the above processes for the case of 31-MeV X-rays. Therapy techniques are discussed in some detail, and depth doses, phantom methods, applications and beam intensity measurements and patient protection are dealt with. Dosage rates of 16–44 r/min were reached. J. D. CRAGGS

615.849 : 537.533.08

7800. Film dosimetry of electrons in the energy range 0·5 to 1·4 million electron volts. J. FLEEMAN AND F. S. FRANTZ, JR. *J. Res. Nat. Bur. Stand.* [*Wash.*] **48**, 117–20 (*Feb.*, 1952).

Two types of films were exposed to electrons in the energy range 0·5 to 1·4 million electron volts. The film response was found to be linearly proportional to the dosage received and independent of the energy of the incident electrons in the measured energy range. The photographic density is further shown to be dependent on the amount of paper absorber surrounding the film. A step-wedge filter is suggested that would permit extrapolation of densities to zero filter thickness. A.

615.849

7801. P^{32} beta sources for superficial therapy. W. K. SINCLAIR AND H. BLONDAL. *Brit. J. Radiol.*, **25**, 360–8 (*July*, 1952).

Radioactive phosphorus incorporated into thin polythene plastic for use as a β-ray applicator in superficial therapy is described. Measurements made with a shallow ionization chamber show surface dosage rates of the order of 1 500 to 2 000 r/hour. Depth dose measurements were made in unit density material and compared with similar measurements made with a 45 kVp X-ray plant. The protection problems are discussed and safe methods of handling and preparation of the applicators are described. The initial response to this β-therapy of five patients with superficial rodent ulcers, and two patients with psoriasis, is presented. Preliminary clinical investigations show that the lesions to be treated must be carefully selected. The method appears applicable in particular to patients with multiple basal cell carcinomata. A.

615.849 : 539.16.08

7802. Calculations for distributed sources of beta radiation. H. H. ROSSI AND R. H. ELLIS, JR. *Amer. J. Roentgenol. Radium Ther.*, **67**, 980–8 (*June*, 1952).

These calculations enable good estimations of clinical dosage from β-ray-emitting radio isotopes to be made. [For their mathematical derivation see Abstr. 8955 (1950), 2009 (1951).] Experimental graphs show the variation of an "effective average" absorption coefficient with maximum energy of the emitted β-rays, and the variation of dose rate with distance from slabs of β-ray emitters of various thickness. From these curves the dose rate from β-ray sources of different thicknesses and energies may be obtained. Examples of practical cases are given. Similar calculations cover the cases of spherical emitters and cavities. Dosages from other

shapes are obtained by building up from spheres; the method is applied for a mouse thyroid containing I^{131}. D. V. MABBS

616–073.75

7803. The use of filters to control radiation exposure to the patient in diagnostic roentgenology. E. D. TROUT, J. P. KELLEY AND G. A. CATHEY. *Amer. J. Roentgenol. Radium Ther.*, **67**, 946–63 (*June*, 1952).

The authors set out to show that it is possible to produce radiographs of equal clinical value when filters are added to the X-ray beam; doses received by patients are then considerably reduced. Radiation intensities transmitted through sheets of Al of up to 3 mm, by X-rays of 50–130 kV, are tabulated. Depth-dose curves are shown for beams of 50–130 kV when filtered by 0–3 mm Al. From these results it is seen that much of the incident radiation in an unfiltered beam is not used in producing the radiograph. Many tables show the relative skin and depth doses received as filtration is increased. With 2 mm Al filtration and 50–70 kV, the skin dose is often reduced to $\frac{1}{3}$ of its value with no filter. Plates of comparative radiographs confirm that the corresponding change in detail and contrast with filtration is small, and th authors advocate using a minimum of 2 mm Al fo all radiographs, and progressively more as the X-ra voltage is increased. Proceedings of a short discussio are appended. D. V. MAB

616.314–07

7804. The translucent zone of reaction in the denti A radioautographic study. H. BERGGREN AND CEDERBERG. *Ark. Fys.*, **4**, 565–71 (*Paper* 41, 1952).

Rats were subjected to a caries-producing diet, an injected with varying amounts of P^{32} 2–4 days befo death. Sections of the jaws and teeth were prepare and autoradiographs made by one of three metho described. Plates are given, and results showed th the translucent zones in the dentin corresponding affected areas of the enamel, take up P^{32} to a f greater degree than adjacent parts. Confirmatio that the translucent zone is not an impermeab barrier is thus provided, and P^{32} is indicated as important tool in studying mineral metabolism dental hard tissues. D. V. MAB

TECHNICAL MATERIALS 66/67

669

7805. The preparation at room temperature of gold-silver alloys in powder form. F. HUND AND E. TRÄGNER. Note in *Naturwissenschaften*, **39**, 63 (*No.* 3, 1952) *In German.*

See also Abstr. 9888 (1951). Alloys of various compositions were prepared as precipitated powders by alkaline formaldehyde reduction of solutions containing the appropriate amounts of Ag and Au nitrates. X-ray measurements, after suitable heat treatment of the powder to give sharp lines (4 hr at 350°c), confirmed that the products were true alloys, the lattice parameters agreeing exactly with those of alloys made by other methods. A. D. LE CLAIRE

669

7806. The preparation at room temperature of gold-mercury alloys in powder form. F. HUND AND H. MOSTHAF. Note in *Naturwissenschaften*, **39**, 209 (*No.* 1952) *In German.*

This is achieved by the method previously describ for Ag–Hg [Abstr. 9888 (1951)] and Ag–Au allo (preceding abstract). Lattice parameter determin tions, as a function of the Hg content, gave resu agreeing well with those previously reported f Au–Hg alloys. A. D. LE CLAI

669 : 536.4

7807. Preparation of grey tin. E. S. HEDGES A J. Y. HIGGS. Letter in *Nature* [*Lond.*] **169**, 621 (*April* 12, 1952).

White tin is transformed to grey by cold worki and subsequent "annealing," both at solid CO_2 te peratures. The rate of transformation increases w the purity of the tin. Grey tin powder so prepar may be converted to oxide-free white tin powder heating in warm water. A. D. LE CLAI

PHOTOGRAPHY 77

771.3

7808. The influence of various physical factors on the fading of the latent image due to ionizing particles. J. THOUVENIN AND P. DEMERS. *C.R. Acad. Sci.* [*Paris*] **234**, 1968–9 (*May* 12, 1952) *In French.*

The results of experiments carried out with nuclear track emulsions made in the laboratory are briefly described. At 25°c and for humidities of 70 to 90% R.H. the influence of atmospheric oxygen on the rate of fading is small. A small initial growth in grain density has been observed in the tracks of α-particles emitted during the disintegration of thorium, but this increase is not observed when conditions are su that fading is small. For proton exposures, the gr density D_t at time t after exposure is given $D_0 - D_t = a + bD_0$ where a and b are functio of time but not of D_0. There are three fading perio (1) for small fading, b is zero, and equal numbers grains fade in equal intervals of time: (2) for th days at 25°c and 90% R.H., $b = 0{\cdot}32$, $a = 0$ grains per micron, and equal proportions of gra fade in equal time intervals; (3) after strong fad the grain densities of tracks show small furt variation with time. A. C. COA

771.35

09. The cos⁴-law in photographic objectives. E. J. NEUGEBAUER. *Z. wiss. Photogr.*, **46**, 187–8 (*No.* 10–12, 1951) *In German.*

Previous work, particularly that from non-German urces, is briefly reviewed. Ten references.

R. W. FISH

771.5

10. Studies in the resolving power of photographic nulsions. IV. The effect of development time and veloper composition. F. H. PERRIN AND J. H. LTMAN. *J. Opt. Soc. Amer.*, **42**, 455–61 (*July*, 1952). For Pt III, see Abstr. 3183 (1952). Three types of nulsion were studied for resolving power as a nction of development time, and one type was udied with six developers. In all cases the relation scribed in the recent literature was confirmed, amely, a rapid rise to a maximum, followed by a ght drop to an approximately constant value. An verse logarithmic relation between exposure and the velopment time required to give maximum resolving wer was found to hold for a moderate range of velopment times, but the constant of proportionality ried with the photographic material. When the aterials were developed to the customary fractions their γ-infinities, however, the exposure required r best resolution was practically independent of velopment time. Except for a certain thiocyanate veloper, all the developers studied gave substantially ne same resolving power for practical gammas. At tremely low gammas, the resolving power was about 0% higher than for practical gammas except in the ses of the borax and the thiocyanate developers, for hich the values were about 40% higher. The drop resolving power with increase in gamma was owest for the thiocyanate developer, but at the ghest gammas attainable with this developer the solving power was the same as for the others. A.

771.5

311. Studies in the resolving power of photographic nulsions. V. The effect of reduction and intensification. F. H. PERRIN AND J. H. ALTMAN. *J. Opt. Soc. mer.*, **42**, 462–6 (*July*, 1952).

The effects of six common reducers and four ommon intensifiers have been studied on a high ntrast positive emulsion, a fine-grained panchroatic negative emulsion, and a high-speed negative nulsion. It was found that reducers generally injure solution, cutting reducers most of all, although the mple persulphate reducer improves resolution at w densities. Intensifiers vary according to no eneral rule, and some have little effect on resolution. lost of them are somewhat deleterious at low and edium densities, the silver intensifier being least so, ut all improve resolution at high densities. No vidence was found for Scheffer's statement that a nse in Farmer's reducer will dissolve the resolved ortion of the image without much affecting its ensity. A.

771.5

812. Investigations of the exposure scales of haracteristic curves of photographic emulsion layers. . P. H. TRIVELLI. *J. Opt. Soc. Amer.*, **42**, 467–74 *July*, 1952).

The application of a quantum theory of photographic exposure to photographic films of extended exposure latitude is studied, and it is shown that the density-log exposure data of such materials are incapable of representation by equations based on the simple theory. The applicability of binary functions, as well as functions based on variable intrinsic sensitivity (ε) or quantic sensitivity (γ) of the emulsions, is examined for a number of exemplary films, including some experiments on the effects of supersensitizing-optical sensitizing combinations. A.

771.53

7813. On the action of oxidizing agents on the latent image of solarization, and the interpretation of reversal phenomena based thereon. H. ARENS. *Z. wiss. Photogr.*, **46**, 237–40 (*No.* 10–12, 1951) *In German.*

After heavy exposures, oxidizing agents applied before development did not promote a regression of solarization, except in the case of Farmer's reducer. This conflicts with the theory that the Ag-specks increase in size in solarization. S. T. HENDERSON

771.53

7814. On the mode of action of desensitizers. I. A. HAUTOT AND H. SAUVENIER. *Bull. Soc. Roy. Sci. Liège*, **21**, 79–94 (*March*, 1952) *In French.*

Several emulsions were desensitized by pinacryptol yellow, phenosafranine, or aqueous K_2CrO_4, and the sensitometric properties determined over a wide range of exposure. Comparisons of the H and D curves of normal and desensitized emulsions show varied effects on the slope of the curve and the maximum density attainable, while the importance of light intensity (as distinct from exposure) varies in different cases. In general desensitized emulsions have a steeper slope due to a more uniform grain sensitivity than in the original, and a higher maximum density indicating that initially insensitive grains have become developable. This is caused by donation of electrons to the less active centres by the adsorbed dye, though its normal function in desensitization is to be reduced by photoelectrons. S. T. HENDERSON

771.53

7815. On the mode of action of desensitizers. II. A. HAUTOT AND H. SAUVENIER. *Bull. Soc. Roy. Sci. Liège*, **21**, 95–101 (*March*, 1952) *In French.*

Continuing previous work [preceding abstract], desensitized emulsions were washed for varying times and the recovery of sensitivity determined. The desensitization remaining after prolonged washing was greater for the more sensitive emulsions, and it is concluded that the dye is more strongly adsorbed on the grains determining the threshold sensitivity, and is less easily removed from these grains by washing. Chromic acid differs in its action from the other desensitizers used. S. T. HENDERSON

771.534

7816. Gold in photographic emulsions. Remarks on work under the same title by R. Koslowsky. K. MEYER. *Z. wiss. Photogr.*, **47**, 1–2 (*No.* 1–3, 1952) *In German.*

The sensitizing effect of gold [Koslowsky, Abstr. 690 (1952)] was first described by Kropff [*Photogr. Ind.* 1145 (1925)]. S. T. HENDERSON

771.534

7817. Fundamental mechanisms of photographic sensitivity. *London, Butterworth Scientific Publications* (1951) 345 *pp.*

Proceedings of a symposium held at the University of Bristol in March, 1950. Forty-eight articles. For abstracts of some, see Abstr. 7818–43, 7850 (1952).

771.534

7818. Coloration of alkali halide crystals by high energy radiation. H. PICK. "*Photographic sensitivity*," 9–12 [see Abstr. 7817 (1952)].

Discusses the coloration of alkali halide crystals by α-, β-, γ- and X-radiations. In addition to the *F*-bands which are already well known, *V*-bands located close to the absorption edge characteristic of the lattice are also produced. The properties of the *V*-bands are compared with those of the *F*-bands and a model for the centre responsible for them is deduced. A.

771.534

7819. Optical and thermal activation processes in X-ray coloured crystals. E. E. SCHNEIDER. "*Photographic sensitivity*," 13–23 [see Abstr. 7817 (1952)].

Experimental results are presented on the coloration produced in single crystals of alkali halides by irradiation with X-rays. The mechanism of coloration is discussed in the light of the measurements as a function of X-ray dosage. Visible coloration, consisting of the *F*-band and secondary absorption bands, is described as well as the ultraviolet absorption associated with the trapping of positive holes as "*V*-centres." Results on optical bleaching by irradiation in the *F*-band and on thermal bleaching of *F*-centres in the dark are considered in detail. It is shown that these processes can be interpreted in terms of unimolecular activation mechanisms characterized by very small values of the activation rate and by activation energies of 0·2–0·3 eV. A theoretical model for photochemically coloured crystals put forward to account for the experimental results is based on the assumption of an association of *F*-centres and positive holes in coloration complexes. A.

771.534

7820. Optical demonstration of presence of Schottky disorder in silver bromide. O. STASIW. "*Photographic sensitivity*," 24–32 [see Abstr. 7817 (1952)].

Further experimental work on the optical absorption properties of mixed crystals of silver bromide with silver sulphide is reported. The impurity absorption band in the mixed crystals is now attributed to the presence of isolated divalent sulphide ions in the lattice. The absorption coefficient decreases with the time elapsing after the crystal has been cooled to room temperature. It is assumed that this decrease is due to the slow formation of complexes between divalent sulphide ions and vacant bromide ion lattice sites. These results therefore suggest that, in addition to Frenkel disorder, there may be an appreciable fraction of Schottky disorder in silver bromide. A.

771.534

7821. Diffusion in silver bromide crystals containing silver iodide. J. TELTOW. "*Photographic sensitivity*," 33–5 [see Abstr. 7817 (1952)].

The effect of bromine vapour on AgBr–AgI mixe crystals containing about 1 mol % AgI has bee investigated. The defect electron migration which induced is modified by groups of iodide ions i corporated in the lattice; these are able to capture th defect electrons. This result is of interest in co nection with the primary photochemical process AgBr–AgI gelatin layers.

771.53

7822. Effect of light on development and etching single crystals of silver bromide. C. G. BOISSONNA "*Photographic sensitivity*," 36–8 [see Abstr. 781 (1952)].

The reduction of prepared plane surfaces of silv bromide by suitable chemical reagents produc oriented grains of metallic silver. The effect exposing such surfaces to a pencil of light befo development is to change the surface density of the developed grains. It is shown that the rate of etchi attack of grain surfaces by potassium bromide sol tions is also influenced by prior exposure of th surface to a pencil of light.

771.53

7823. Oriented growth of silver during electr bombardment of silver chloride. D. W. PASHLE "*Photographic sensitivity*," 39–45 [see Abstr. 781 (1952)].

Silver chloride tarnish layers formed on silv crystal surfaces have been found to be stable und electron bombardment; the chemical development these layers has been investigated by means of electr diffraction. Oriented layers of silver chloride prepar on mica have been reduced to silver by electr bombardment, and it is shown that the silver gro mainly in an orientation parallel to that of the silv chloride. Repeated twinning is also found to occu These observations are considered to be of interest connection with the theory of the photographic late image.

771.5

7824. Diffusion of silver and bromide ions in silv bromide suspensions. T. B. GRIMLEY. "*Photograph sensitivity*," 46–52 [see Abstr. 7817 (1952)].

An attempt is made to calculate the self-diffusi coefficients of silver and bromide ions from publish data on the rates of exchange of radioactive ions wi silver bromide suspensions. The results show that t self-diffusion coefficients of both ions are of the sa order of magnitude (about 10^{-14} cm^2/sec) and th they increase slightly as the particle size increas If diffusion in the solid is due primarily to the moti of isolated single vacant sites, this increase may explained immediately in the light of a recent theo of the electrical double layer at the interface betwe silver bromide and an electrolyte. On the other ha the fact that the calculated self-diffusion coefficie are of the same order of magnitude for both io suggests that diffusion takes place through the moti of neutral pairs of vacancies. This being so, t explanation of the apparent trend in the diffusi coefficients with particle size must be sought el where.

771.534

7825. Self-diffusion of silver and bromine in silver bromide and silver chloride. K. E. ZIMEN. "*Photographic sensitivity*," 53–5 [see Abstr. 7817 (1952)].

The results of experiments on ion exchange with radioactive isotopes in the silver halides show that only silver ions are exchanged at a measurable rate at room temperature. This is consistent with the occurrence of Frenkel lattice disorder. The experimental results of Langer are discussed and his interpretation of them is criticized. A.

771.534

7826. Some properties of colloidal silver bromide. A. K. HOLLIDAY AND K. N. DAVIES. "*Photographic sensitivity*," 56–60 [see Abstr. 7817 (1952)].

Electrophoretic mobility measurements on silver bromide sols indicate that the ζ-potential depends primarily upon the concentration of silver or bromide ions in the electrolyte. When silver nitrate is used to give high silver ion concentrations, adsorption of nitrate ion appears to increase with time, reducing the initially high ζ values and rendering the sol unstable. The use of silver fluoride largely prevents adsorption and a fairly stable sol results. Addition of small amounts of methylene blue or sodium fluoresceinate at high Ag^+ concentrations produces no effect with the former, whereas with the latter both the sign and magnitude of ζ are changed. A.

771.534

7827. Interpretation of the characteristic curves of photographic materials. P. C. BURTON. "*Photographic sensitivity*," 188–207 [see Abstr. 7817 (1952)].

Aims to show that the characteristic curves of photographic materials can be understood to a fair extent without inquiring into the basic mechanism of the photographic process and, more generally, to explain a number of concepts and lines of thought that may prove useful to the emulsion maker and latent image theorist in thinking about the physical meaning of the characteristic curve. The following topics are discussed: graphical approaches; differing interpretations of intensity-scale and time-scale curves; effects of emulsion thickness, wavelength, development time, and grain size and number; effect of quantum fluctuations; the characteristic curve treated as a problem in kinetics; the characteristic curve treated as a distribution curve; and a general method of interpreting characteristic curves in terms of grains and quanta. A.

771.534

7828. Influence of static pressure during exposure on the sensitivity of photographic materials. H. ÄCKSTRÖM. "*Photographic sensitivity*," 208–14 [see Abstr. 7817 (1952)].

The influence of static pressure on the ionic conductivity of pure silver halides has been quantitatively correlated with its influence on the sensitivity of photographic materials in terms of the Gurney–Mott theory of the formation of the latent image. Measurements have also been made in which the exposure under static pressure was divided into two parts, one made under high and the other under low applied pressure. The results which were obtained depended on the order in which the exposures were made, and possible reasons for this are discussed. A previously unrecorded optical pressure effect is reported. A.

771.534

7829. Solarization and its dependence on the wavelength of the exposing light. H. SAUVENIER. "*Photographic sensitivity*," 215–19 [see Abstr. 7817 (1952)].

It has been shown that with both commercial and experimental emulsions red and infrared light can produce the phenomenon of solarization. The degree of solarization generally decreases towards longer wavelengths. Light of longer wavelength produces a re-reversal of the surface image, the cause of which is probably the Debot effect. For certain emulsions the amount of deep internal image formed by red light increases, when compared with the deep internal image produced by light of shorter wavelength, with increasing exposure time. A.

771.534

7830. Lattice defects and latent image formation in silver halides. J. W. MITCHELL. "*Photographic sensitivity*," 242–58 [see Abstr. 7817 (1952)].

The evolution of the ideas from the Gurney–Mott theory of the formation of the latent image is described. Certain aspects of the evidence for the nature of the lattice defects in the silver halides are then reviewed and the conclusion drawn that the simultaneous presence of interstitial silver ions, vacant bromide ion lattice sites and vacant silver ion lattice sites must be taken into account in formulating theories of photographic sensitivity. The consequences of assuming this model for the lattice disorder are then developed, the interaction of electrons and positive holes with the oppositely charged ionic lattice defects being discussed and a general account of the mechanisms of photographic sensitivity on this basis being given. The formation and distribution of the latent image in non-chemically sensitized grains, the processes of chemical sensitization and the formation and development of the latent image in chemically sensitized grains are considered. The influence of the environment of the silver halide emulsion grain, including the effects of adsorbed surface layers, on the detailed mechanisms of sensitization and latent image formation deduced on the basis of this extended theory will be discussed in a later paper. The theory presented here is considerably more complicated than any previous theory because the simultaneous participation of a number of alternative mechanisms in the formation of the latent image in emulsion grains is envisaged. A.

771.534

7831. Preparation and sensitization of electron-sensitive nuclear track plates. L. JENNY. "*Photographic sensitivity*," 259–64 [see Abstr. 7817 (1952)].

Details are given of a highly concentrated silver bromide emulsion which can be prepared by simple laboratory methods. Addition of a derivative of 3, 5-dimethylpyrazole to the emulsion produces electron-sensitive plates suitable for nuclear research. Plates can be coated with emulsion layers up to 400 μ thick. A search was made for a powerful sensitizer for electron-sensitive nuclear track plates. Substances containing NH_2- or OH— groups were found to be

suitable if their standard oxidation-reduction potential was higher than 800 mV. The sensitizing effect increases if heterocyclic groups are present in the molecule. The sensitization of photographic plates towards particles of low ionizing power is tentatively explained as a transfer of electrons liberated in the sensitizer by the passage of the ionizing particle. A.

771.534

7832. Effects of diluting nuclear emulsion type G5 with gelatin. E. C. DODD AND C. WALLER. "*Photographic sensitivity*," 266–71 [see Abstr. 7817 (1952)].

The dilution of nuclear emulsion type G5 with gelatin does not produce the expected reduction in the density of relativistic particle tracks, and for equal fog background (obtained by adjustment of development time) emulsions with normal and twice normal gelatin give tracks which are the same within experimental error. It is shown that the mean sensitivity of the grains of fully concentrated emulsion is less than that at greater dilutions. A.

771.534

7833. Track recognition in nuclear track emulsions. R. W. BERRIMAN. "*Photographic sensitivity*," 272–85 [see Abstr. 7817 (1952)].

The effect on track recognition of variations in the silver halide/gelatin ratio for various degrees of fog and for various track densities has been investigated by means of artificial fog and track diagrams. The results obtained indicate that there is a range of values for this ratio over which recognition is optimal. As the present ratio for NT emulsions lies within this range, no improvement in recognition would be expected by changing the ratio. The results indicate, however, that track recognition varies only slightly with the silver halide/gelatin ratio around the optimum, and an increase of up to 50% in the proportion of gelatin used in NT emulsions could be made without significant loss in recognition, but an increase of 100% in the amount of gelatin would result in such a loss. The results obtained with actual emulsions agree with these predictions. A.

771.534

7834. The "print-out effect" produced by alpha particles from polonium in nuclear emulsions. L. WINAND. "*Photographic sensitivity*," 206–8 [see Abstr. 7817 (1952)].

The existence of a direct "print-out effect" has been demonstrated in Ilford C2 nuclear emulsions exposed to α-particles. The polonium source for these measurements was a disk 3 mm in diameter, the initial intensity being 250 microcuries. A frame and a source carrier were constructed to provide a system the geometry of which allowed the calculation of the number of particles required to fall on a given surface of the plate to produce the minimum visually observable print-out effect. The distance from the source to the plate which was mounted parallel to it was known precisely. A.

771.534

7835. Latent image fading phenomena in nuclear emulsions. G. ALBOUY AND H. FARAGGI. "*Photographic sensitivity*," 290–6 [see Abstr. 7817 (1952)].

The external factors influencing fading have been studied. The law governing the disappearance of latent images as a function of time and the behaviou of minimum ionization emulsions in this respect hav also been examined. Taken together, the results ca be interpreted in terms of the action of atmospher oxygen on latent image specks. A procedure described which permits the accelerated fading minimum ionization emulsions without any reductio in their sensitivity.

771.53

7836. On processing nuclear emulsions; concernin temperature development. C. C. DILWORTH, G. P. OCCHIALINI AND L. VERMAESEN. "*Photograph sensitivity*," 297–309 [see Abstr. 7817 (1952)].

Details are given of the temperature cycle metho for the uniform development of nuclear researc emulsions of thicknesses up to 2 mm. The metho by which discrimination may be obtained betwee particles of very high ionizing power are brief discussed. A. C. COAT

771.53

7837. Some applications of pH buffers in the develo ment of nuclear particle plates. G. W. W. STEVEN "*Photographic sensitivity*," 310–16 [see Abstr. 781 (1952)].

Experiments are described (1) on attempts modify discrimination between the tracks of differe nuclear particles by controlled under-developmen and (2) on a developer giving uniform developme through thick NT4 (Minimum Ionization) plates wi good reproducibility. Both investigations demande control of the pH and activity of the developer b buffering. Striking discrimination between α-partic and fission tracks was produced in emulsion, but le favourable results were obtained in other emulsion Controlled under-development may prove useful as supplementary method, but cannot replace corre choice of emulsion. The metol developer devised f NT4 plates gave minimum ionizing tracks whi could be followed right through plates 200 and 400 thick processed by the temperature cycle method.

771.5

7838. Experimental study of the law governing t production of developable grains by charged partic as a function of their energy. M. MORAND A L. VAN ROSSUM. "*Photographic sensitivity*," 317– [see Abstr. 7817 (1952)].

The relation

$$\frac{\Delta N}{\Delta R} = c\left\{1 - \exp\left[-b\left(\sqrt{\frac{\Delta E}{\Delta R}} - \sqrt{a}\right)\right]\right\}$$

between the density of grains along proton tracks photographic emulsions and the specific energy l in the same residual range has been investigat experimentally and values of the constants have be determined.

771.5

7839. Estimation of the sensitivity of nuclear tra plates. A. C. COATES. "*Photographic sensitivit* 320–6 [see Abstr. 7817 (1952)].

The visibility of a nuclear particle track is det mined by the concentration of grains per unit len in the track and of grains per unit area in the ba ground fog. A theoretical reason is given why visibility is a function of the ratio of the number

g grains to the square of the number of track grains. his relation has been observed for tracks in experiental NT plates. Further confirmation was rnished by examination of plates developed for fferent times. As a preliminary to the above vestigation an examination was made of the distriution of grains in tracks. It was found to be nomial in character, and random. A.

771.534

340. Determination of shrinkage factor in nuclear search emulsions using an interference method. A. ROADS. "*Photographic sensitivity*," 327–30 ee Abstr. 7817 (1952)].

Interference fringes between the emulsion surface nd an optical flat are used to measure the change in ope of a wedge of emulsion before and after processg. The fringes are photographed and the shrinkage ctor S determined from measurements made on the sultant negative. By processing only half of the edge and using the glass support as a reference slope, can be calculated from one photograph. Provision made in the apparatus for measuring S in atmoheres of different relative humidities. A.

771.534

341. Shrinkage and moisture content of photoaphic emulsions for nuclear research. J. ROTBLAT ND C. T. TAI. "*Photographic sensitivity*," 331–7 ee Abstr. 7817 (1952)].

Dependence of the shrinkage of Ilford C2 emulsions n their moisture content was investigated by working ith emulsions at various values of the relative umidity of air. It was found that the shrinkage is ways greater than would be expected if it were due the washing out of silver halides alone. The oisture content of the processed emulsion was ound to be considerably lower than that of the nprocessed emulsion. An empirical formula was ound for the shrinkage factor as a function of the lative humidity of air during exposure and observaon. For thick emulsions the shrinkage factor was ound to be the same throughout the depth of the nulsion. The directly measured shrinkage factor an be used to correct the length of tracks only if ne angle of dip is not too large. For angles of dip reater than about 25° in the tracks of heavily ionizing articles the correction for shrinkage has to be smaller nan the shrinkage factor. A.

771.534 : 535.371

342. Low temperature fluorescence of silver halides nd photographic emulsions. G. C. FARNELL AND . C. BURTON. "*Photographic sensitivity*," 61–73 ee Abstr. 7817 (1952)].

The low temperature fluorescence of pure, impurity ctivated, and mixed crystals of the silver halides has een examined in some detail. The majority of bservations refer to spectroscopic recordings made t liquid nitrogen and liquid hydrogen temperature, ut some attention has been paid to such topics as ne excitation spectra and the temperature-dependence f fluorescence intensity. The most important general esult is that the pure halides themselves fluoresce at ow temperatures (they do not show any phosphoresence), their emission bands all lying just to the long avelength side of their respective absorption edges. The emission spectra of the mixed halides have been interpreted from a knowledge of the spectra of the single halides and the extents of mixed crystal formation between them. A phenomenon of some interest is that small quantities of silver produced in a halide by an exposure of latent image magnitude activate a characteristic red low temperature fluorescence. The main results are discussed in terms of a simple model for the absorbing and emitting centre. It is shown that the limited results obtained for the temperature-dependence of fluorescence intensity are quite compatible with theoretical considerations. The bearing of the results on the low temperature exposure of emulsions is considered; some photographic experiments are described, the results of which show that a low temperature exposure of a bromo-iodide emulsion is rendered inefficient by the fluorescence of the halide. A.

771.534 : 537.312.5

7843. Correlations between photographic and photoconductive sensitivity of silver halides. W. WEST. "*Photographic sensitivity*," 99–111 [see Abstr. 7817 (1952)].

The photoconductivity of normal photographic emulsions can be measured with exposures below the print-out and solarizing ranges. This effect can be utilized as a means of isolating the primary changes in latent image formation. It has been investigated in relation to: optical sensitization, in which increased photographic sensitivity within the wavelength region absorbed by the sensitizer is accompanied by a parallel increase in photoconductivity; desensitization by dyes, an example of a photographic sensitivity change not intimately determined by changes in the primary liberation of electrons; and finally chemical sensitization by sulphur sensitizers, an illustration of increased photographic sensitivity accompanying decreased photoconductivity, consistent with a mechanism of increased effective trapping. Divalent cations, Pb^{2+} and Cd^{2+} introduced into thin gelatinless films of silver bromide produced a sixfold increase in photoconductivity without marked change in absorption or in spectral distribution. A photoconductive negative effect was observed with unannealed gelatinless crystals of silver bromide which showed a decreased conductivity on exposure to light. This "negative effect" can also be induced by bathing a crystal in silver salts and drying and is inhibited (1) by treatment of Br^-, or by substances capable of forming complexes with Ag^+, (2) by annealing, (3) by suspending in gelatin, (4) by lowering the temperature, and (5) by introduction of Pb^{2+} and Cd^{2+}. Well adsorbed halogen acceptors increase the photoconductivity of emulsions and also increase the rate of formation of photolytic silver. A.

771.534.17

7844. Chemical sensitization of a silver–bromide sol by adjustment of the silver ion concentration. E. E. LOENING. *Photogr. J. B*, **92**, 126–7 (*July–Aug.*, 1952).

The addition of Ag ions to a AgBr sol (bromide body), its conversion into a Ag-body sol, results in chemical sensitization; this is borne out by a considerable increase of gamma of the time-scale curve of the sol, by a conversion of the originally concave into a convex curve and by elimination of the reversal.

The resulting H and D curve closely resembles those obtained by addition of other chemical sensitizers, e.g. nitrite or gelatin to a sol; it is, in fact, similar to that of a conventional photographic emulsion. This effect is strongly dependent on the pH; it almost disappears entirely at a low pH (about 3·0). Comparison of the effect of pH- and pAg-adjustment of a AgBr sol shows that these effects are very different in magnitude and, most probably, in their nature. It appears difficult to explain this difference on classical lines according to which these effects are due to one and the same cause, i.e. to a change of the efficiency of Br acceptance. A.

771.534.3

7845. A photographic low intensity desensitization effect. R. E. MAURER AND J. A. C. YULE. *J. Opt. Soc. Amer.*, **42**, 402–7 (*June*, 1952).

A new photographic phenomenon, a low intensity desensitization effect ("L.I.D. effect") is described. With certain solarizable emulsions, it was found that the latent image formed by a short, high intensity exposure was destroyed by a subsequent long, low intensity exposure. If the low intensity exposure was given first, it desensitized the emulsion. Thus, in both cases the density resulting from the two exposures was lower than the density obtained by the short exposure alone. Sensitometric data on this desensitization effect are presented. Previous work relating to it is briefly reviewed, and its relation to other double-exposure effects is outlined. Substitution of X-ray exposures for the high intensity exposures show that both act in the same manner under the experimental conditions used. Practical applications of the new effect as a reversal process and for colour correction in reproducing coloured originals are suggested. A.

771.534.55

7846. The nature and evaluation of the sharpness of photographic images. G. C. HIGGINS AND L. A. JONES. *J. Soc. Mot. Pict. Televis. Engrs*, **58**, 277–90 (*April*, 1952).

The ability of a photographic material to produce pictures having good definition is commonly referred to as its sharpness, which is a subjective concept. The objective quantity $\langle G_x^2 \rangle_{Av}$. DS is shown to be a physical measurement which correlates with sharpness judgments. $\langle G_x^2 \rangle_{Av}$ is the mean of the square of the density gradients, $\Delta D/\Delta x$, across an abrupt boundary between a light and a dark area in the developed image and DS is the density difference between these areas. $\langle G_x^2 \rangle_{Av}$ is evaluated only for those values greater than 0·005 in density per micron which represents the threshold gradient. It is shown that, contrary to the generally accepted belief, resolving power does not correlate well with sharpness judgments and in some cases is even misleading. A.

771.535

7847. Effect of electrons on photographic emulsions. S. G. GRENISHIN. *Zh. Tekh. Fiz.*, **22**, 33–9 (*No.* 1, 1952) *In Russian.*

A sensitogram was printed on one half of a plate, the whole plate was then subjected to the action of an electronic beam (*c.* 50 keV) from an electron microscope, following which a second sensitogram was printed on the other half of the plate; the plate was then developed, and the darkening was measured b means of a photoelectric microphotometer. It wa found that a large number of "sub-centres" (latent image centres) were formed when electrons impinge on the photographic emulsion. Properties of th sub-centres due to light were very similar to those o sub-centres caused by electrons. The results of th effect of electrons depended upon the sensitivity o the emulsion. When the emulsion was little electron sensitive, the centres of latent images were similar t those due to an illumination of short duration an great intensity. When, however, the electron sensitivity of the emulsion was great, the centres o latent images resembled those caused by an illumina tion of long duration and feeble intensity. F. LACHMA

771.53

7848. On the theory of the Sabattier effect. W BRAUN. *Z. wiss. Photogr.*, **47**, 27–39 (*No.* 1–3, 1952 *In German.*

Arens' theory [Abstr. 7497–8 (1949); 3655, 692 (1950)] is extended, and discussed in the light o measurements both on the Sabattier effect, and als on the Herschel effect to X-rays, using a variety o emulsions. The magnitude of these two effect together with the sensitivity to light, characteriz each emulsion. The influence of an intermediat infrared exposure on the Sabattier effect depends o the proportion of surface and internal latent image Some experiments on desensitized emulsions a described. S. T. HENDERSO

77

7849. The width of photographically produce pictures of slits and its use for the measurement "turbidity" of the emulsion layers concerned. M. VIGON. *Optik*, **9**, 154–62 (*No.* 4, 1952) *In German.*

Turbidity is due to scattering and absorption light in the emulsion and results in changes in th ratio of black to white widths when a pattern equal black and white strips is photographed. Plo are shown of log exposure E *v.* the difference between black strip width in the photograph and t corresponding clear strip width in the negative ("object"), allowing for magnification. The plots a straight lines varying in slope with the magnificatio but with a common intersection on the log E ax Thus at a certain exposure the widths are equal, a independent of the width w of the intermediate zon between black and white in the object, these zon being of varying density due to turbidity. Oth plots show that D varies linearly with w for any giv value of log E. The turbidity is defined as dD/d log which can be determined from the experimental da Previous work is briefly discussed. S. T. HENDERS

778

7850. Application of the photographic plate to t investigation of problems in nuclear physics and cosm rays. P. H. FOWLER AND D. H. PERKINS. "*Pho graphic sensitivity*," 340–5 [see Abstr. 7817 (1952)

Describes the three measurements that can be ma on the tracks of particles in an emulsion, namely t residual range, the scattering and the ionizatio The way in which these measurements are influenc by the characteristics of the plate and its developm is discussed. Finally methods are given for obtain

alues for the mass, charge and velocity of the particle om these measurements. A.

778.3

851. A new nuclear research emulsion. A. J. IERZ AND C. WALLER. Letter in *Phil. Mag.*, **43**, 92–4 (*May*, 1952).

A nuclear research emulsion of low sensitivity, ype G.O., has been produced to facilitate the measurement of the tracks due to heavy nuclei. This emulsion iffers from the G.5 emulsion in sensitivity only, and an be processed by exactly the same methods as the G.5. emulsion. This makes it possible to use sandviches of G.O. and G.5 emulsion on the same lass base. A. C. COATES

778.3

852. A photographic chamber for electron-optical pparatus. L. LAFOURCADE AND R. DARGENT. *. Phys. Radium*, **13**, 274–7 (*May*, 1952) *In French.*

Describes a cassette of novel design holding five ·5×9 cm plates, which has been used for precision ecording of electron diffraction patterns. R. S. PEASE

778.3

853. On the fluctuation of the grain density of the tracks due to] relativistic particles observed in a uclear emulsion. M. MORAND AND TSAI-CHÜ. *.R. Acad. Sci.* [*Paris*] **234**, 2534–6 (*June* 23, 1952) *n French.*

The distribution of the grain density of tracks due o 3394 minimum ionization particles recorded in G.5 mulsions shows a marked maximum at 27 grains per 00 microns, and is more symmetrical than the heoretical energy-loss distribution. A. C. COATES

778.33

854. The physical background of contrast in oentgenograms with special regard to scattered adiation. S. LEDIN. *Stockholm Diss.*, 111 *pp.* (1952).

Concerns the general influence of secondary radiation on the radiographic image of bodies having low tomic number, and possible ways of approaching optimal contrast. Methods of measuring the contrast n radiographs produced with or without Bucky iaphragms, are presented. A mathematical treatment concerning the size and material of grids, and he absorption of primary and secondary radiation y them, is given. The effect of increasing X-ray oltage on contrast is discussed in the light of experimental results. Measurement of radiation intensities with a photocell is detailed. The extension of the calculations to allow for heterogeneity of the X-ray eam is touched upon. An appendix contains many experimental curves showing variation of total and scattered radiation at depths in water when grids of various materials and sizes are used. D. V. MABBS

778.33 : 537.533 : 621.384.61 : 620.179.152

855. 31-MeV radiographic inspection of metal parts. R. WIDERÖE. *Brown Boveri Rev.*, **38**, 301–10 (*Sept.–Oct.*, 1951).

Deals in detail with the physical possibilities of high-energy X-radiography with a betatron. Exposure times for various specimen conditions and the fault sensitivity are discussed quantitatively. A selection of typical photographs is given and discussed. J. D. CRAGGS

778.3 : 539.17

Photo-electric determination of the density of tracks in nuclear emulsions. *See Abstr.* 7536

778.33 : 535.376

7856. Production of monochromatic X-radiation for microradiography by excitation of fluorescent characteristic radiation. T. H. ROGERS. *J. Appl. Phys.*, **23**, 881–7 (*Aug.*, 1952).

In several types of applications of microradiography, particularly for histochemical and microchemical analysis by X-ray absorption spectroscopy, it is desirable to use monochromatic radiation of a wavelength selected specifically with reference to an absorption edge of the element of interest. An X-ray tube having as its target a material whose K_α characteristic wavelength is suitable is the most usual source of monochromatic X-radiation. In many cases, however, an otherwise desirable target is physically unsuitable for use as a target inside a vacuum tube. Hence, the possibility of producing fluorescent characteristic radiation with intensities sufficient for microradiography becomes of interest. The very high intensity of the primary X-ray beam made available by the newly developed Be-window X-ray tubes suggests new possibilities for the excitation of fluorescent radiation. This paper reports the results of exploratory work attempting to establish the factors governing the intensity and degree of monochromaticity of fluorescent X-radiation. Several materials, ranging from Ti (atomic number 22) to Mo (42) were studied comparatively, with exciting radiations of various characteristics; Ti was studied in greater detail. It is concluded that a considerably higher degree of monochromaticity is obtainable by this method than by direct bombardment and that intensities useful for some aspects by microradiography are obtainable. A.

778.33 : 539.16.08

7857. On the use of roentgen films in dosimetry. G. D. ADAMS. *Amer. J. Roentgenol. Radium Ther.*, **67**, 991–2 (*June*, 1952).

It is found that, in the 20 MeV X-ray region, photographic density increases linearly with exposure up to at least density = 4. Eastman "Industrial" types A and M, and Eastman "No Screen" behaved in this way when a lead screen (0·04 in) was incorporated in the cassette between target and film. Plots of exposure in roentgens against density, are shown. D. V. MABBS

778.33 : 616.24–073.75

7858. Fluorography with the aid of a mirror system. W. H. BOLDINGH. *Philips Tech. Rev.*, **13**, 269–81 (*April*, 1952).

For this method, used for mass chest survey, a camera with a Schmidt mirror system was constructed. The pictures are 40 mm×40 mm and are recorded on non-perforated 45-mm film. The forward travel of the film is fully automatic, as is also the entire operation of the installation for mass chest survey. Some typical details of the mirror camera are dealt with more closely, e.g. the device for pressing out the film spherically (in the Schmidt optical system the focal plane is concentrical with the concave mirror), the adjustment of the camera, etc. The choice of the

film size and the light-gathering power reached are treated at some length. The resolving power proves to be very high over the whole of the field of vision (about 25°). A.

778.34 : 539.17

7859. On the probability of formation of stars from successive disintegrations in photographic emulsions. R. FLAMENT. *Bull. Cent. Phys. Nucléaire, Bruxelles, No.* 3, 5 *pp.* (*Aug.*, 1948) *In French.*

Single tracks and stars which may arise from radioactive contamination are discussed. Graphs show the relative numbers likely to be found in emulsions up to 700 hr after manufacture. Track ranges are summarized to assist identification. J. J. WILKINS

778.34

7860. Testing a "histophotographic track" method of localizing the cells of radioactive elements. C.-M. GROS, P. CÜER AND R. RECHENMANN. *C.R. Acad. Sci.* [*Paris*] **234,** 2236–8 (*May* 26, 1952) *In French.*

Using liquid nuclear emulsions, it is possible to localize radioactive atoms in a histologic section precisely. The method of impregnating and staining a section is described. After development, particle tracks are counted under high magnification and a quantitative dose can be arrived at. The microphotographs and results for a liver section injected with thorotrast are given. The method has been successfully applied to the β-rays of I^{131} and P^{32}. Much weaker activities are required than for ordinary autoradiographs. D. V. MABBS

778.34

7861. The Herschel effect and selective erasing of nuclear emulsions. A. M. GOLDSTEIN AND C. H. SHERMAN. *Rev. Sci. Instrum.*, **23,** 267–71 (*June*, 1952).

The Herschel effect has been used as a means of obtaining selective erasing of nuclear emulsions. Radiation which produces background fog is often unavoidably present in an experimental arrangement designed for the registration of the tracks of heavy ionizing particles. It has been possible to erase background darkening which would have completely obscured tracks without erasing any of the tracks, thus extending useful exposure periods. The possibility of selective erasing by use of the Herschel effect is presented in terms of the Gurney and Mott theory of latent image formation. Background darkening on Eastman Kodak NTA emulsion was produced by visible light X-rays, γ of Co^{60}, and β of Sr^{90}–Y^{90}; the 5·3 MeV α-particles of Po^{210} were used to obtain the individual tracks. By use of an infrared exposure the permissible background exposures were increased by factors of 3–7, without destroying any of the tracks. Other information regarding the Herschel effect has also been obtained. A.

778.34

7862. An apparatus for the measurement of multiple scattering of tracks in nuclear emulsions. N. C. BARFORD AND R. M. TENNENT. *J. Sci. Instrum.*, **29,** 217–18 (*July*, 1952).

A projection microscope, modified for measurement of the small-angle scattering of tracks observed in nuclear emulsions, is described. The apparatus has been used to determine the masses of cosmic-ray particles which come to rest in the emulsion. If single scatters are eliminated, a function of the scattering angle and the range may be found which is independent of energy and has a Gaussian distribution. A.

778.34 : 535.247.4

7863. On a photometric method for the identification of electrically charged particles in thick photographic emulsions. G. KAYAS AND D. MORELLET. *C.R. Acad. Sci.* [*Paris*] **234,** 1359–61 (*March* 24, 1952) *In French.*

By focusing the image of a track of a nuclear particle on to a slit, behind which is a photo-multiplier tube, the grain density of the track can be measured in terms of the light transmitted by the slit. Ilford G–5 emulsions coated 600 microns thick were used, and corrections were applied for the depth of the track in the emulsion layer and for the angle of dip in the emulsion plane. In the case of singly charged particles, this method cannot readily distinguish between π and μ mesons, but it can differentiate the heavier mesons (τ and K) from protons and protons from deuterons. A. C. COATES

778.6 : 541.14

7864. On the photochemistry of the bleach-out process. A. POLGAR. *Z. wiss. Photogr.*, **46,** 188–237 (*No.* 10–12, 1951) *In German.*

The work dates from 1933 and includes an account of investigations prior to that date. Theories of the sensitivity of dyes to light and the mechanism of sensitization by other substances are discussed, also the sensitometry of dye layers and the approximate mathematical treatment of the bleaching reaction. Experiments were made on a variety of dyes to show the effect on bleaching of time of exposure, of intensity of illumination, of concentration of sensitizer (anethole or thiosinamine), and of initial concentration of dyestuff. The effects of bleaching mixed pairs of dyes were also studied. S. T. HENDERSON